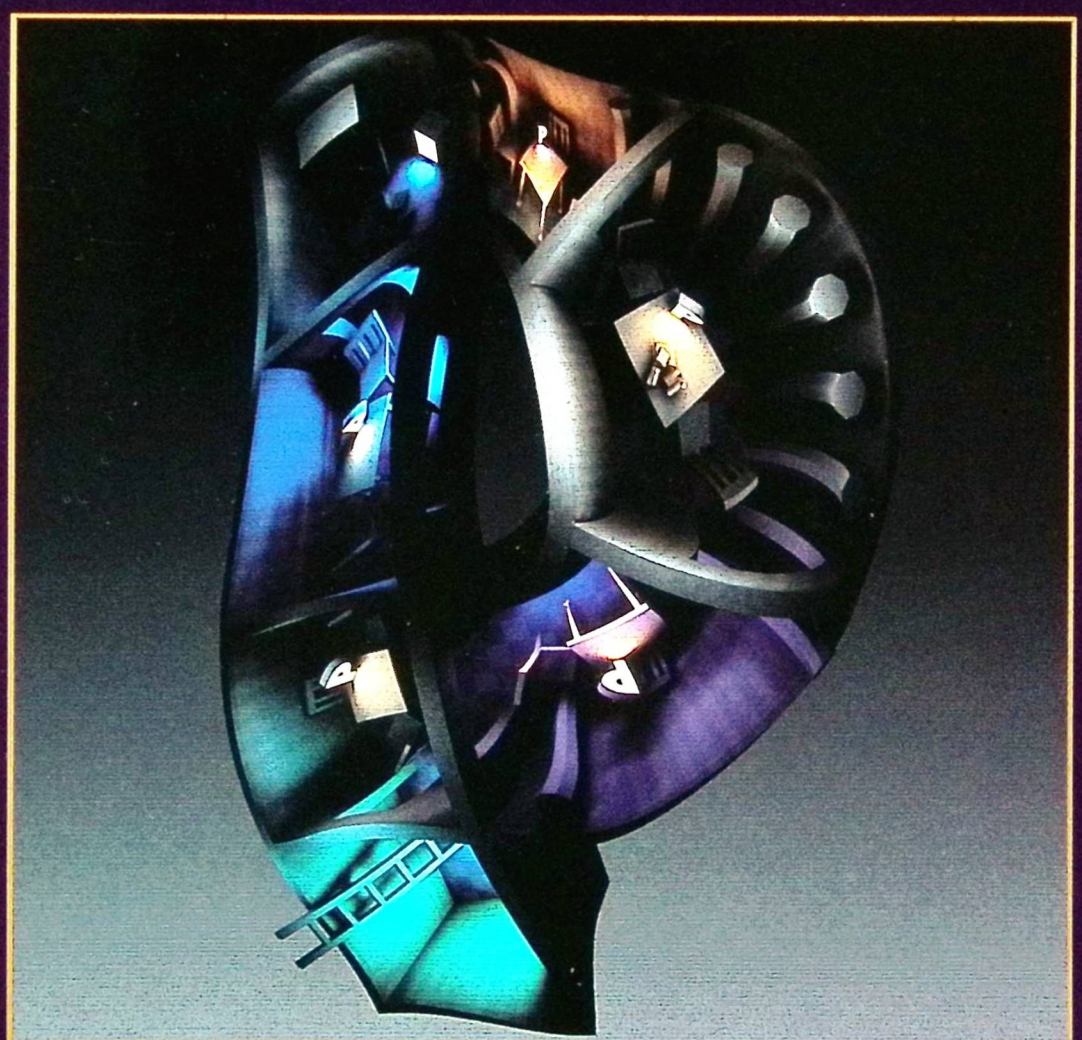
THE MAGAZINE OF VISUAL PROCESSING

NUMBER SIXTEEN/FOUR DOLLARS

# IRIS universe™



VISUAL PROCESSING IN THE LAND OF THE RISING SUN

BASEBALL GOES DIGITAL

YACHT DESIGN IN THE UNITED KINGDOM

# To save time.

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0.000 0.000 0.000 0.000 0.000
0.000 -13.516 -6.158 0.374 -3.199
0.000 -12.069 -8.037 1.078 -2.975
0.018 -9.722 -12.263 0.620 -2.631
0.497 -3.189 -11.245 0.890 -2.340
0.427 -3.600 7.234 -4.837 -1.049
0.000 -25.560 5.720 -1.062 -0.443
0.000 -22.133 6.017 0.036 -0.476
0.000 -20.055 7.025 -0.695 -0.457
0.000 -19.844 7.802 0.589 -0.458
0.000 0.000 0.000 0.000 0.000
0.000 -12.828 -3.820 -0.157 -3.460
0.000 -11.598 -6.443 -0.075 -2.923
0.058 -12.361 -9.148 -0.316 -2.296
1.883 -8.944 -10.794 -1.030 -1.727
0.070 -16.862 -8.708 -0.144 0.097
0.000 -24.751 0.526 0.669 -0.247
0.000 -21.240 4.779 0.036 -0.253
0.000 -19.399 7.124 0.073 -0.288
0.000 -19.455 8.180 0.107 -0.277
0.000 0.000 0.000 0.000 0.000
0.000 -11.694 -0.869 0.346 -3.462
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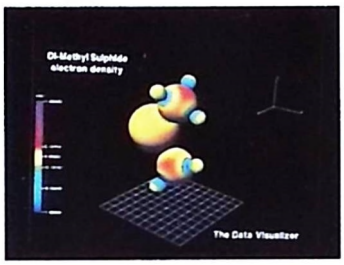


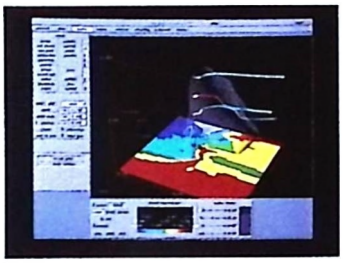

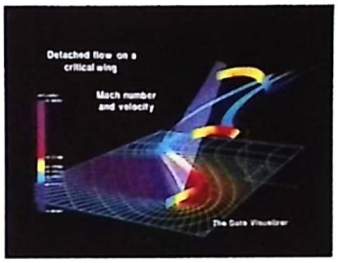


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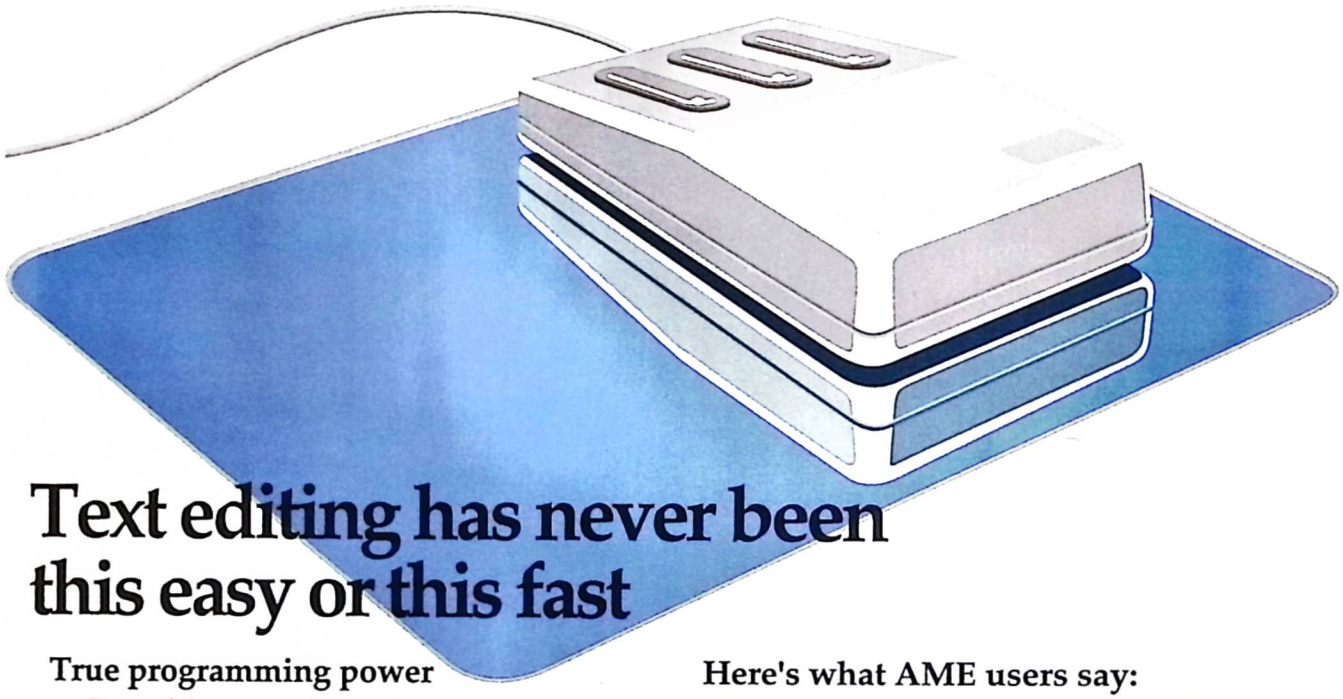

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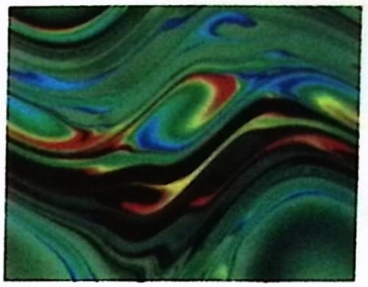

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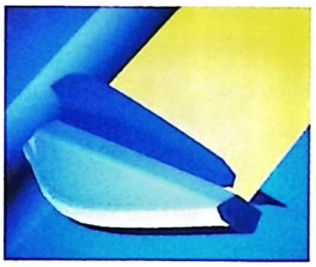
ISSUE NUMBER SIXTEEN

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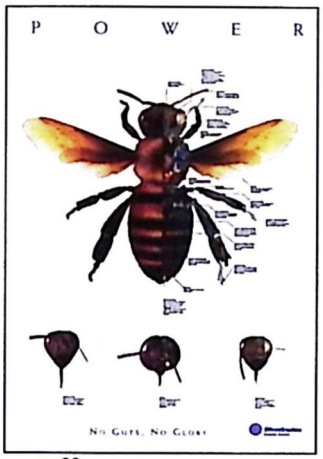


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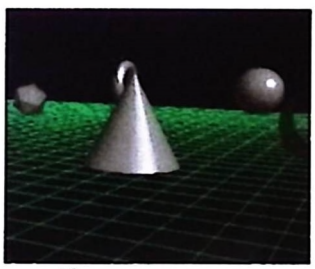

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**Editor** Douglas Cruickshank

**Associate Editor (International)** Crispin Littlehales

**Contributing Editor** Gaye Graves

**Art Director** Francesca Angelesco

**Digital Images** Monica Schulze and Paul Haeberli

**Typesetting** Lauren Langford Typography

**Color Separations** Color Response

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**Editorial** Silicon Graphics, Inc.
2011 N. Shoreline Blvd.
Mountain View, CA
94039
415/335-1727

**Circulation** Silicon Graphics, Inc.
2011 N. Shoreline Blvd.
Mail Stop 415
Mountain View, CA
94039
415/335-1293
Fax: 415/968-3579
<*monica@sgi.com*>

**Advertising** Ardith Lowell
*A.J. Lowell and Associates*
2755 Campus Dr. #247
San Mateo, CA
94403
415/341-9681

**Publisher** Mark Compton

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## USER'S NOTE

*In addition to addressing the concerns of people everywhere who use visual processing workstations, we at* IRIS Universe *magazine are especially interested in users of IRIS computer systems. Thus it's appropriate that IRIS workstation users have a forum in this publication. It is also appropriate that Cynthia Traeger author the first "User's Note." As head of George Mason University's Computer Graphics Lab, Traeger is a longtime user of IRIS computers and a founder of Silicon Graphics' Federal Region Users Group, the largest such organization in the country.*

*— Editor*

## LETTER FROM WASHINGTON

Here in the Washington D.C. area (the Federal Region), we have enjoyed a users' group for approximately two years. Meetings are held the last Tuesday of every month, with the exception of December. Sometimes we meet at user sites, with the hosting site usually giving tours and talks about the applications and implementations of Silicon Graphics equipment and software. On occasion the hosting site cannot, for a variety of reasons, provide tours, but can provide meeting space. We also meet at the Silicon Graphics offices in Bethesda, Maryland and have done so quite frequently in the months past. Typically, agendas consist of quick updates to material covered in the previous meeting, a featured speaker or speakers, a question and answer session with our Silicon Graphics liaison, and closing remarks. Usually the next month's topic is set at that time.

Topics vary and have included previews of new operating systems, in-depth classes in parallel programming, discussions of user needs and wants, networking tips, and system administration procedures. Individuals from a wide spectrum of organizations have shared applications and occasionally code from areas such as ray tracing, molecular modeling, terrain mapping, night vision techniques, and projects currently in place at NASA. Sometimes we've merely sat around, complained, and successfully identified issues that legitimately need to be addressed by Silicon Graphics. And they are being addressed, one by one.

Although this is a users' group, the traditional nomenclature does not apply. A partnership between user community and corporation is more accurate. Silicon Graphics provides us with a meeting place if we need one, a systems engineer as user group liaison, and a sales representative if appropriate. It is up to the group to do the rest. Participation and attendance are the key. Normally, meetings are held in the evening. Every fourth month we meet during the lunch hour to provide those individuals who cannot attend in the evening a chance to participate as well.

This non-traditional model provides some unique opportunities not normally available to traditional groups. We are starting to have more direct contact with those ultimately responsible for product development. Silicon Graphics, in turn, is able to determine user wants and needs more quickly, and incorporate them in an appropriate fashion. A very unusual situation exists here and we as users need to take advantage of it.

*— Cynthia Traeger*


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# EXECUTING UNIX COMMANDS FROM FRAMEMAKER HYPERTEXT DOCUMENTS

BY SURESH KATTA AND PRAMOD RUSTAGI

With the hypertext feature in FrameMaker 2.1, a desktop publishing program from Frame Technology, there is a simple way to extend a document with the ability to execute a Unix shell script or any user application.

Normally, one would use hypertext to create on-line help or on-line manuals. The hypertext facility in Frame allows readers to explore information non-sequentially, along the links that are written into the document. The author creates active areas associated with either a text phrase, a user supplied graphic or a pre-defined icon, so that the reader can click on the active area for more information. This could invoke such actions as popping up an alert message, bringing up a different page within the document, opening up a related document, or allowing the reader to choose among several actions from a pop-up menu.

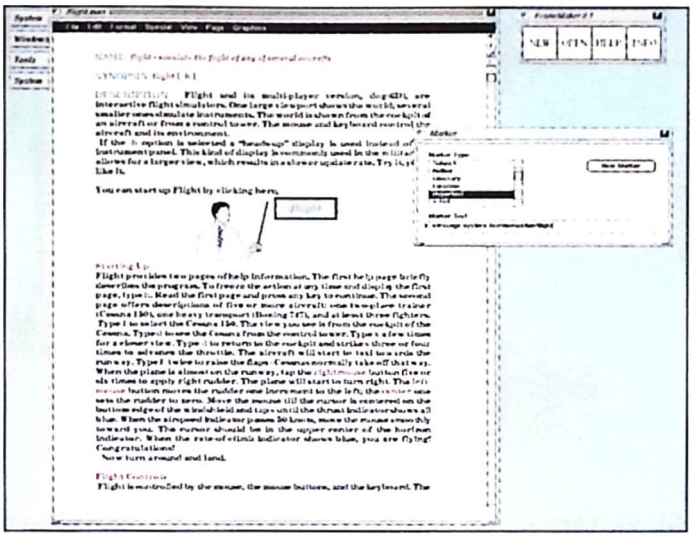
In the accompanying example, we are constructing the *flight.man* document to automatically execute the *flight* program when the reader clicks on the button graphic. In the first image, we set the *hypertext* insertion point at the appropriate spot, bring up the marker dialogue box, and enter the system message to invoke as the *hypertext* command. FrameMaker executes this command using the UNIX *system()* call. If the reader clicks on the *flight button* in the document, the *flight* program is invoked, as in the second image. With the *flight* program running, the reader experiences simulated *flight*, not just the manual entry that describes it.

In the last image, the author has attempted a landing and incorporated the *flight* scene into the document. This is done by using the *capture/import* image facility from the Frame pop-up menu.

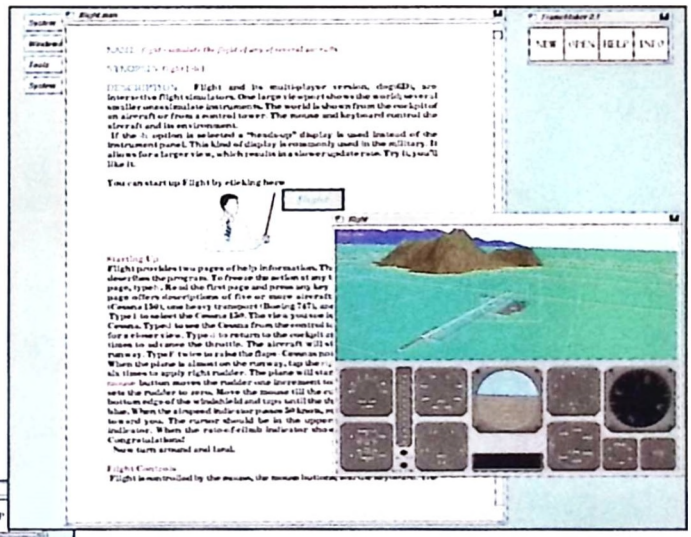
The *hypertext* system message is just one way to extend FrameMaker. For an in-depth explanation of the complete set of features, the "Hypertext Documents" chapter in the *FrameMaker Reference Manual* and the manual *Integrating Applications with FrameMaker* are required reading.

---

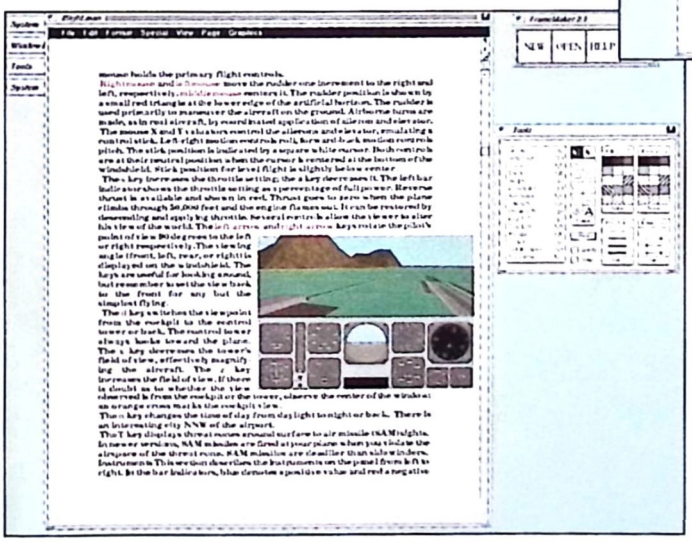
*Suresh Katta is an engineer at Silicon Graphics. Pramod Rustagi is a manager in Silcon Graphics' Software Express group.* ●



*adding a* **hypertext marker** *to the Frame document*



*invoking* **flight** *by clicking on the flight button*

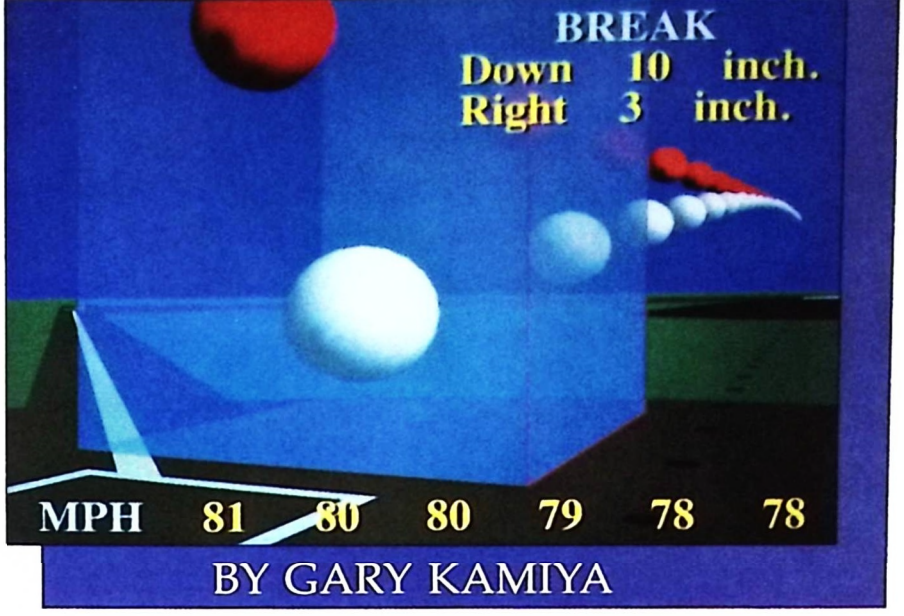


*capturing the* **flight** *scene into the document*

# CRUNCHING BASEBALL:

## THE GRAND OLD GAME GOES DIGITAL

*A new video-computer system that provides real-time analysis of pitching techniques promises to bring fundamental change to America's favorite pastime.*




BY GARY KAMIYA

Baseball people have their own special and arcane wisdom. They are on intimate terms with things outsiders don't even notice — the way a shortstop turns his body when he comes across the bag on a double play, the changing rotation on a pitcher's curve as he's beginning to tire. A scout or a manager can register a minute hitch in a prospect's swing (and so consign him forever to the lower minor leagues) as casually as he flicks off ashes from his White Owl.

It's not surprising that these laconic poets of the summer game have always turned their noses up at attempts to quantify and measure it. The radar gun, which measures the speed of a pitch, has hitherto been the only high-tech instrument allowed to defile the sport. Baseball men tolerate the gun, but they still rely primarily on their instincts and their eyes. And why not? You wouldn't expect a man who can tell that a pitcher's slider is losing its "bite" from eighty feet away to roll out the carpet for Godless technology.

This year, however, the "If-ah-cain't-see-it-hit-doan-matter" school of baseball analysis faces its greatest challenge. A new video/computer/graphics system threatens to revolutionize the way the game is taught, prepared for, and evaluated. It is a system of such power and accuracy — more than that, it's so much fun — that even the most hardened baseball Luddites may go on-line.

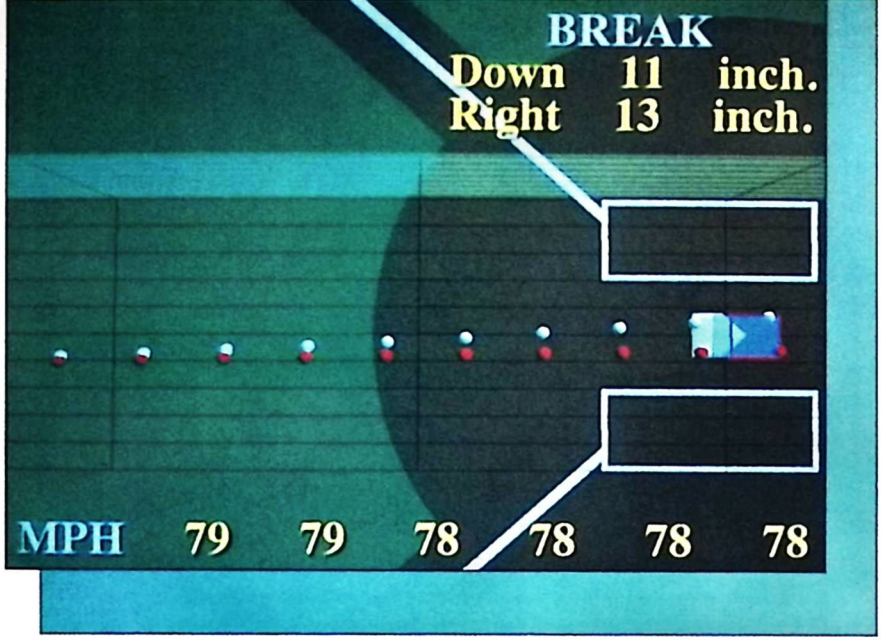
The invention, called "Supervision," allows a coach or player to see on a video screen, almost instantly, the pitch just thrown — and learn virtually everything he needs to know about it. The screen, which gives an umpire's eye-view of the action, displays the actual trajectory of the pitch (represented by a series of "baseballs") coming right at the observer. It shows the ball's location in the strike zone and the two most critical factors, besides speed, of the pitch: its drop and its horizontal movement. It gives the pitch's speed at release and its velocity at the end. It displays on command the last six pitches thrown, their order, speed, type (curve, change-up, etc.), and indicates whether they were balls or strikes, fouls or hits. Finally, a second, "theoretical" ball can be displayed to show the same pitch without rotation — thus revealing how much "stuff" the pitcher put on the actual pitch.

Using Supervision, pitchers can try out different release points and grips and get instant feedback. Batters can prepare for opposing pitchers by studying their actual pitches on the monitor. Coaches can evaluate pitchers with greater accuracy than ever before. And all of us who for years have been solemnly nodding our heads as announcers talk about sliders, straight changes, and split-fingers will find out what those pitches actually look like.

The system is the brainchild of Michael Harris, an engineer and former pilot who now heads the flight simulation department for Tracor Flight Systems. The idea came to Harris a decade ago, when he was watching a dull baseball game. "It wasn't a very exciting game," says Harris, a native of Vancouver, B.C. "There were few baserunners, and the one thing to look at was the pitching. Well, when you watch pitches you can't really tell where the ball went. You have to take the announcer's word for it. I thought it would increase the interest level of the games if you could actually see the pitch." Harris used two principal techniques to realize his notion: triangulation and scene cancellation. Triangulation is used initially to establish the exact location of the ball: scene cancellation; to track its movement.

The Supervision system starts with two video cameras; one on the third base side of the pitcher's mound, one on the first base side. Located 150 feet above ground in the upper bleachers at a 45 degree angle to the field, the cameras are able to take in the entire area from mound to catcher's glove. Since their exact position is known, the position of the ball as it leaves the pitcher's hand can be determined by triangulation, the same technique used by surveyors.

Having established that, ball locations are then plot-




ted along the pitch's trajectory using scene cancellation. This is a technique in which the spatial information taken from a camera frame (there are thirty frames per second) is first converted into digital form by a Silicon Graphics 4D/210 GTX workstation, then subtracted from the next frame. Since the ball appears in a slightly different place in consecutive frames, this allows the course to be exactly plotted — and displayed on the video screen or print-out.

"Everything is done using either off-the-shelf products or well-known mathematical techniques," Harris says of Supervision, which cost a modest $250,000 to develop. According to programmer Mike Lim, the company chose Silicon Graphics as the platform for generating the graphics because of "the quality of the graphics and the performance speed versus the price. It offered high-end stuff at an affordable price."

Major league baseball has recently taken notice of the system —in March the Los Angeles Dodgers signed an agreement with Sportsight, the company that is marketing Supervision — and it's likely that television networks may use it as a "color" device in the near future. The product stirred up considerable interest at the baseball winter meetings, according to Harris's brother, Brian, who's president of Sportsight, and they have since taken it to Florida for spring training games. "Our plan," Harris says, "is to lease it to teams for $950,000 a year — including spring training, broadcasting, and games. They can then lease the service to the networks or pipe it into luxury boxes and make some of their money back." Lim points out that the system may have lighter applications as well. "Supervision could be translated into a video game. People could compete in a realistic way. Now when you hear people in a bar saying, ' I could have hit that pitch.' you can find out". The prospect of watching a noisy, well-watered lout in a rugby shirt swinging and missing repeatedly at 68-mile-an-hour fastballs may prove to be the invention's greatest contribution to American culture.

Steve Boros, the former Oakland skipper who's now minor league field coordinator for the Dodgers, was impressed with what he saw of Supervision. "We saw it in Arizona, in the Instruction League at the end of October," Boros says. "It's a very precise way to analyze a pitch — and we got results. We had one kid who's only been pitching one year. He was throwing with his thumb up on top of the ball, and he was very resistant to advice. His eyes were seeing what he wanted to see. But once we showed him (on the screen), he changed his grip."

According to Boros, certain venerable baseball truisms may be called into question by Supervision. "Another left-handed pitcher threw the ball holding it across four seams, not two seams," he said. "You're supposed to get more sinking when you hold it across only two. But his ball had more movement when he held it his way. It violates an old baseball belief."

Boros says that although "Scouts can't evaluate at this level of precision," the computerized eye-in-the-sky won't threaten old-time scouting. "We still need the radar guns, the guys going around to two games a day," he says. But he thinks Supervision may provide a winning edge. "It's got a chance to have a real impact. I'll just say that in the [1988] World Series Kirk Gibson knew he was going to get a backdoor slider [courtesy of Oakland's Dennis Eckersley]. That kind of information can help you win. And this system can give you that kind of information."

Computers — in baseball? Is this the end of the Garden of Eden? Hardly. A machine can't predict what a living human being is going to do when he faces Will Clark with the bases loaded. But it can give players and viewers alike a clearer look at what happens in that beautiful second of violent motion that is the heart of baseball.

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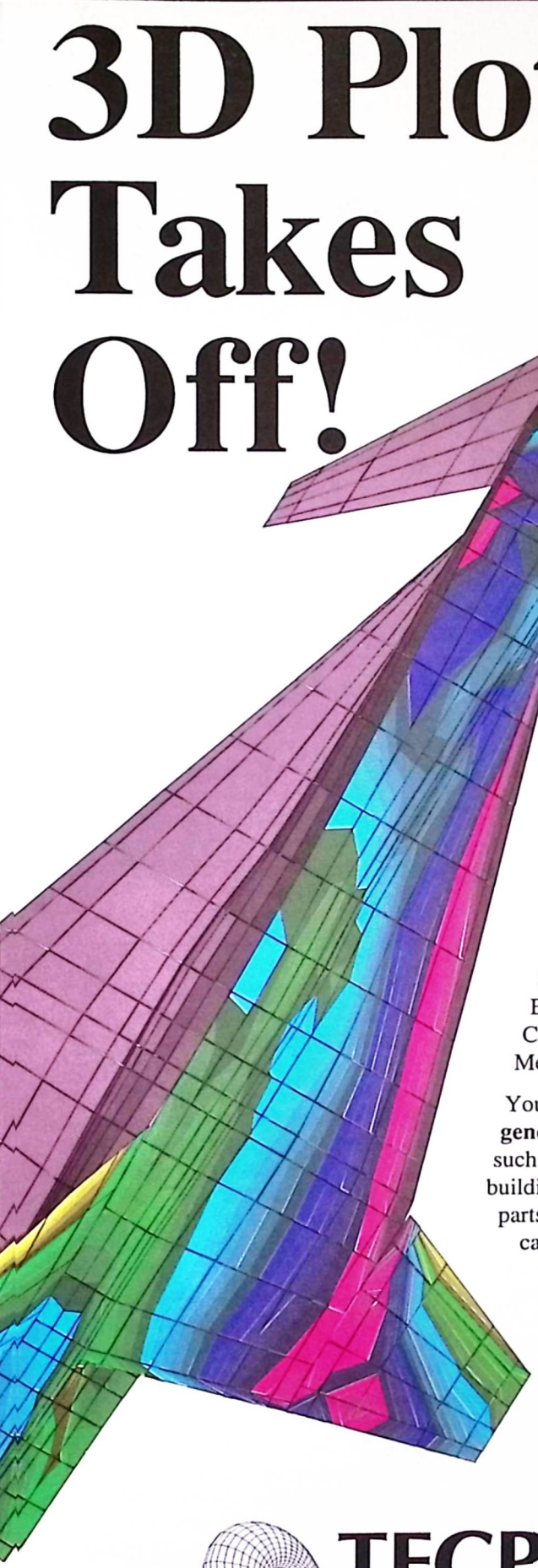
*Gary Kamiya is Senior Editor at the* San Francisco Examiner's *Sunday magazine,* Image. ●

# 3D Plotting Takes Off!



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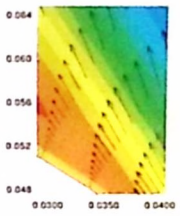


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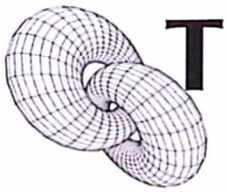

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# SMOOTH SAILING

BY MICHAEL PARSONS

Yachts designed by Tony Castro Ltd win races all over the world. The company's founder describes himself as "Primarily a designer who likes slick boats." Recently, he has started using slick graphics workstations to ensure total accuracy in the design and production of some of the world's fastest and most expensive yachts.

Tony Castro Ltd. is a firm of naval architects and yacht designers. The company has designed boats ranging from America's Cup racing yachts to the yachts seen on the BBC television series "Howard's Way". The business was founded in Ireland ten years ago, but has now moved to the shores of the River Hamble near Southampton, the center of yacht racing in the United Kingdom.

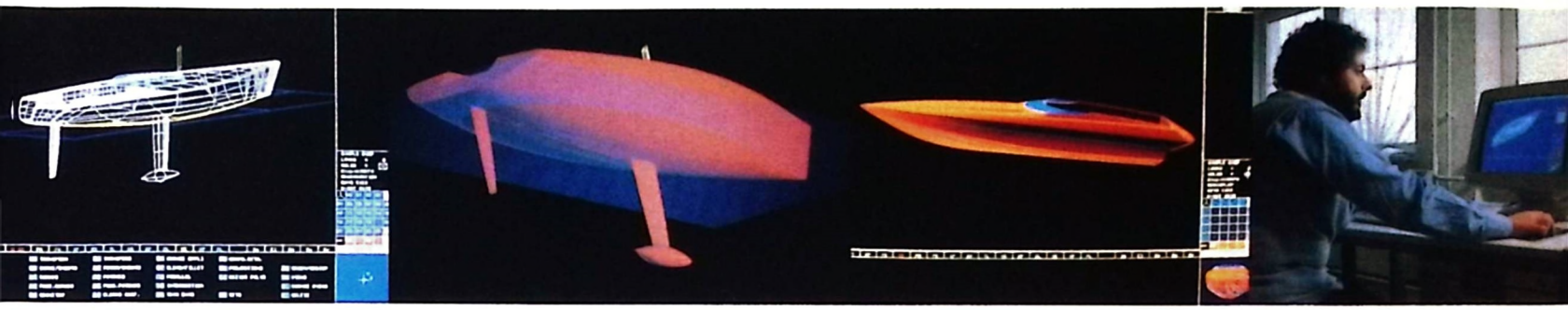
Yachts designed by the firm are purchased by customers from all over the world — helped no doubt by the company's ability to converse with boat builders in five languages.

The company has been extremely successful at winning contracts from the world's top yachtsman to design very fast yachts. Clients have come from the United Kingdom, Germany, Hong Kong and the United States. The firm has produced super yachts, like a million dollar 55 foot ketch for an American owner, as well as power boats like the 12 meter craft design for Kineo/Porsche of Germany.

The company also designs boats for mass production. Every year about 800 production boats of their design are launched by boat-builders around the globe.

Speed is essential in yacht design. Yachts are a high-performance craft and many are designed as "one-offs". Production of these tailor-made craft is a highly specialized business, and the industry is committed to the highest standards of design and craftsmanship. The people who work in the industry do it because they love yachts. Many see themselves more as artists or craftsmen than engineers or designers.

*British designer Tony Castro creates some of the world's fastest, most expensive yachts using some of the world's fastest, most affordable graphics workstations.*



In this kind of "craft" culture many of the people involved shy away from new technology, but Tony Castro Ltd stands out as a company committed to leading-edge computer systems. Castro himself is adamant that there is a place in the yachting world for computer aided design (CAD) and computer aided manufacturing (CAM). The result is that his company is a pioneer in the use of CAD/CAM in naval architecture.

"There is a logical argument for CAD/CAM in this industry. The people who design and build yachts are perfectionists. This technology enables them to make things precisely the way they have designed them,"says Castro.

Yachts are high-performance craft like aeroplanes, and minute attention to detail is needed to ensure that the hydrodynamics — the aerodynamics of the sea — are exactly right.

"We create our yachts on computer and then send the information straight to a milling machine to cut out the designs. The alternative is to send the drawings to a man with a piece of sandpaper," says Castro.

He uses a small network of Hewlett-Packard computers for CAD applications. These generate accurate representations of the initial design information. The technology gives clients an immediate response to their basic idea. It also allows builders and designers to check for flaws.

But as Castro points out, "It's one thing to draw a pretty picture. It's another thing to make it. I had been using CAD for years but I wanted to integrate it with the manufacturing process".

The goal of any design and engineering system must be to narrow the gap between the initial idea and the finished product. Castro needed a system which would ensure that pinpoint accuracy could be achieved, so he installed a Silicon Graphics Personal IRIS workstation running a software package called STRIM 100™ from Cisigraph. STRIM 100 is mechanical design software used by European engineering firms like BMW, Volvo, and Aerospatiale. He was attracted to Silicon Graphics as a hardware platform for several reasons.

"Silicon Graphics is a young, energetic company and the technology offers unrivaled price performance. It is also friendly: other companies can seem too mammoth to deal with, and we need customized support", says Castro.

Juggling the data of a complex design demands a lot of computer power. "The Personal IRIS workstation is fast, good quality hardware", says Castro. "It also has the software we need."

He became convinced of the value of STRIM 100 through working with a German company called Speedwave, which handles some of his manufacturing. The company uses STRIM 100 to produce high-precision moulds, from which production boats can be cast. They are specialists in yacht manufacturing who started off supporting a variety of CAD/CAM applications.

Speedwave became a STRIM 100 house by experience, as they found the software performed better than other CAD/CAM packages. Castro and his designers have followed their lead.

Tony Castro has been using the CAD software on his networked machines to create designs for some time. "I have not done a drawing by hand for two years," he says. Now the company's computerized designs can be imported to the Personal IRIS workstation for manufacturing. The Silicon Graphics machine then generates complex cutting instructions with great precision that control a five-axis milling machine which can cut out a perfect component shape.

This shape is then worked on by craftsmen for final modification. The model can then be scanned by a digitizer head which inputs the true dimensions back to the workstation. This means that no design work is lost, and the computer image can be altered by hand if necessary.

But the system does not just produce models. Life-size moulds of production boats can be created, and the entire keel of a yacht can be cut out. The keel is first rough cast in lead for stability, when it may weigh as much as eighteen tons. Then a heavy-duty milling machine can cut out the final shape with computerized precision using the data from the Personal IRIS workstation. "The system is not just machining a model. It's machining the real thing," says Castro.

Castro decided to adopt STRIM 100 on the Silicon Graphics platform because he saw the results Speedwave was getting with the same system. Since then, Speedwave has had such success with it that aerospace companies like Airbus Consortium and Dornier have become customers. In fact, Castro says he must now compete with these customers for time on the German machines to get his yachts made.

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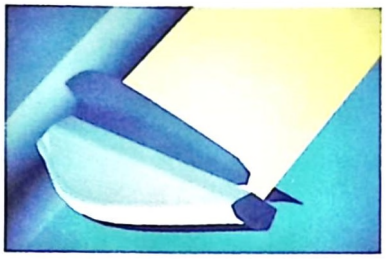

"At the moment there are no English companies doing this work: we would love to hear from English companies who offer this scale of precision manufacturing using STRIM 100", says Castro. "Speedwave has shown there's a big market for the service".

Like Speedwave, Castro has been able to expand his core business because of STRIM 100 and Silicon Graphics. He is now able to offer a specialized design and engineering service for people manufacturing yacht fixtures and fittings. "Our practical experience of yachts, coupled with computers to create accurate designs, has meant an additional role for the company", says Castro.

Castro sees further opportunities for Silicon Graphics in the world of 3D CAD/CAM and claims the company's IRIS workstations are emerging as the platform of choice for the yacht industry. His own company is already developing customized software for keel design on the Personal IRIS workstation and others in the industry have started development work on a 3D package for the complex equations of mathematical flow code, to simulate the movement of water over a keel.

Hull design software, mathematical flow code software, and STRIM 100 are creating a unique set of CAD/CAM tools. Castro sees a great opportunity for Silicon Graphics to lead this new phase of growth in CAD/CAM: "We hope Silicon Graphics will coordinate, integrate, and support this technology and that the IRIS machines will become the CAD/CAM standard in our industry."

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*Michael Parsons is Editorial Director at Hunt Thompson, a London-based high technology public relations consultancy.*

*This article originally appeared in* UK IRIS, *the magazine of Silicon Graphics Limited. For more information about* UK IRIS *or Tony Castro's work, please contact Steve Webb, Silicon Graphics Limited, Forum 1, Station Road, Theale, Reading, Berkshire, United Kingdom, RG7 4RA. Telephone (44) 734 306222.*

# THREE CASE STUDIES IN THE GRAPHIC ARTS

*Associate Editor Crispin Littlehales recently talked with representatives from three companies at the forefront of the technological advances sweeping through the graphic arts industry. Their businesses are quite different, yet all agreed that the IRIS workstation is a workhorse.*

## COMMUNICATION ARTS, LTD.

Communication Arts Ltd. is an English design consultancy based in Egham, Surrey. The company produces all its work using Silicon Graphics computer systems, from design concept to scanning, origination, color separation, pre-press, and final film output. Communication Arts has one Silicon Graphics 4D/20 GT and five 4D/25 GT workstations as well as a Power Series GTX system that's used as a server. Full Color Publisher software runs on all of the machines, as does Wavefront's modeling software and FrameMaker's page layout system. In addition to using an Optronics scanner and Imagesetter system for scanning and color separation, the company produces visuals and proofs on an IRIS Graphics inkjet printer. Pam Fisher founded Communication Arts with colleagues in mid 1989.

Few design firms rival Ms. Fisher's for computer processing power, color electronic pre-press capabilities, and sophistication in turning concept into final print-ready film. Fisher put together the most powerful computing environment available to handle the challenging workload. She identified Silicon Graphics as the platform of choice for two main reasons: open systems and sheer color and image processing power.

"Open systems," she explains, "give us the freedom to use the peripherals and software we want, with the ability to grow and to take advantage of future developments. And the power is critical to our work. Doing color separations and image manipulation in preparation for print is a very compute-intensive activity because of the resolutions involved and because of our need to work in color throughout the process.

"We find the use of color to be particularly important for photorealism. People are very sensitive to certain parts of the color spectrum, and you really do need all 16.7 million colors at your command to enable you to print a good image at the end of the day.

"We also need the control that Full Color Publisher provides, especially when we are dealing with clients who aren't visually literate. It is important for them to see something very close to the final, rather than making them look at cut-and-paste comps or gray magic marker lines.

"We use the system's visual processing capabilities in the areas of photo montage and 3D imagery. By combining scanned backgrounds, such as clouds and skies, with 3D building models, we are able to create very realistic renderings. Clients in the building and land development business are particularly interested in this kind of application."

Still in its first year of business, Communication Arts has already managed to produce high-quality collateral in record time and at considerable cost-savings.

One such project was the design of a bid proposal for a £2 billion construction company. On average the successful bid is worth $15 million so it is mandatory that the company's proposal look good. Communication Arts takes the CAD geometries directly from the customer's dedicated CAD workstation, renders them using Wavefront software, then adds typography and executes page make-up using Full Color Publisher. Utilizing an IRIS Graphics printer, the firm then produces about twenty original, high-quality presentations containing pages of technical information interspersed with three-dimensional models of buildings.

"As this technology comes along," says Fisher, "it can be used to meet the need to enhance visual communications of limited circulation material. Our system is very well suited for that."

The firm also is producing a quarterly 120 page catalog for a company selling PC hardware and software products. "The client wanted more flexibility to accommodate last-minute changes and additions," explains Fisher. "Because we can store the text in a database and treat visuals modularly, we can insert new material into an existing page plan at a very late date. Since we produce the final film, we have full control right along.

"By allowing us to produce the magazine electronically, we've realized great savings in origination and pre-press costs. In fact, we were able to redesign the magazine and move it from a two-color to a four-color format at a fraction of the cost of conventional methods.

"We are using a combination of Full Color Publisher and Frame to handle our text. We now have more than forty fonts on Full Color and over one-hundred PostScript fonts for Frame. Full Color also accepts Frame files in PostScript to allow us to preview the end result, composited on screen. Between the two packages, we have a lot of typographic control, along with the kerning and leading we need."

# POTOMAC GRAPHIC

*"We are creating art and design from scratch, using some of the tools that fall into the special effects area. These include the creation of a watercolor look, an illustrative look, and an embossed look. We also have been working with a new warping capability and have used that successfully on two projects."*

Potomac Graphic Industries, Inc., located in New York City, is a high-end commercial art service that specializes in color electronic pre-press work. About three years ago, Potomac formed a joint venture with Hy Zazula Associates, a long established conventional retoucher. This new venture, called ZER, specializes in creative color services, merging both electronic and conventional capabilities. Between Potomac and ZER, the two companies own four Scitex systems, two Hell Chromacom systems, and a Silicon Graphics GTX graphics superworkstation running the BG-Creator 500 series software package from Barco Graphics.

For the last nine years, Potomac Graphic Industries has been at the forefront of the color electronic pre-press movement. Working with clientele that includes many of New York's leading advertising agencies and corporations — Estee Lauder, Revlon, and Chanel among them — the company has had to maintain the highest standards of quality. The name Potomac Graphic, in fact, has become synonymous with excellence when it comes to electronic retouching, color correction, image manipulation, design, illustration, and color separations.

Melene C. Follert is vice president and technical director at Potomac. Drawing from her more than fifteen years' experience in digital imaging, Ms. Follert is the author of "Data Transmission for the Graphic Arts," as well as numerous articles on the subject. About six months ago, the BG-Creator 500 design system was installed in ZER, primarily to branch out into a new area of creative design. According to Follert, who heads up the company's technical side, the BG-Creator was selected because "it offers similar capabilities to the Quantel Graphic Paint Box system with the added benefit of strong vector capabilities. It also promises to move us into full 3D work."

ZER uses the Creator system for design and concept work as well as for image processing, retouching, color correction, and other pre-press tasks. Steve Zazula, of Hy Zazula Associates,

reports, "Barco Graphics gives us the abilities of a conventional retouching artist which are sorely missed. The systems now in use have rudimentary brush functions and a lack of finesse in rendering fine details. With the Creator's high-resolution and vector capabilities, we overcome the drawbacks of the past and feel confident about the future."

Follert adds, "we are doing some of the same things on the Creator that we do on the Hell and Scitex systems. However, the stronger application for us is in creating art and design from scratch and using some of the tools that fall more into the special effects area. These include the creation of a watercolor look, an illustrative look, and an embossed kind of look. We also have been working with a new warping capability and have used that successfully on two projects so far.

"The system has greatly enhanced the production of comps. It's very difficult to bring in type using the Hell or Scitex. You can build a type library using the Creator and manipulate type as you would on a Macintosh. It remains in the vector format, so you can put it on a curve, color it, tone it, texture it, and so forth.

"Perhaps the biggest gain for us is that the Creator gives us flexibility with the same quality you get with the Scitex and Hell in terms of color selection and high resolution. We normally work with files that may be 4K by 6K."

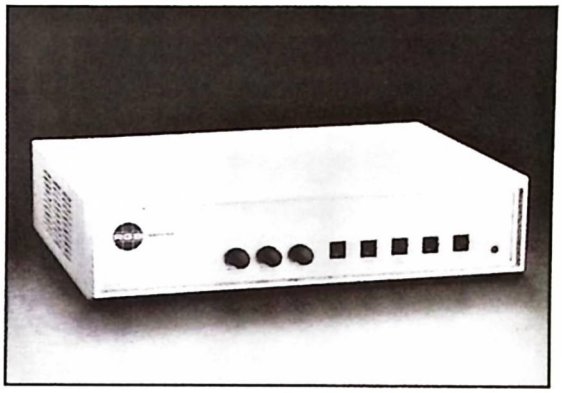
ZER uses 9-track magnetic tapes to communicate to the Scitex and Hell systems. Images are scanned into one system and read into the Creator, where it then can be manipulated and ultimately written to tape for final Hell or Scitex output.

"The other appeal is that it runs on a standard UNIX platform. This means we can take advantage of upgrades and improvements as they come along without spending our own resources," notes Follert.

"So far, the system has lived up to expectations," Follert reports. "The installation took a half day and the initial training for our operator took about a week."

New Model

Convert Computer Graphics to Television



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# COLGATE PALMOLIVE

The Corporate Design Group at Colgate-Palmolive is responsible for producing packaging for a variety of consumer products. In 1989, the group decided to move packaging production in-house. Using Silicon Graphics' Personal IRIS workstations running Xyvision's Contex software, the design team produces mechanical artwork which can then be sent to Scitex via 9-track magnetic tape. The group's director, Michael Penrod, and his three-person production team are currently producing 70 percent of Colgate-Palmolive's mechanicals using only two workstations.

The well known company manufactures hundreds of household products contained in canisters, boxes, bottles, and tubes of all sizes, shapes, and colors. Because uniformity and identity are key, mechanicals have to be exact in every detail. That translates into lots of experimentation and last-minute changes.

"When we decided to move to electronic production of mechanicals, I looked at all of the competitors. The Contex system was the only one out there with enough power to produce mechanicals easily along with the ability to communicate to the equipment used at film separation houses," explains Penrod.

Having Silicon Graphics workstations in place, he says, has enabled Colgate-Palmolive to get packages into production faster and bring products to market sooner.

"Prior to installing the workstations, we used external design firms and mechanical prep houses for mechanical preparation. Now we have control internally and don't have to run back and forth to make changes."

Once a mechanical exists on the Contex system, it can be easily revised or corrected, Penrod notes. "Being able to handle the myriad changes quickly and inexpensively is where the real cost and time savings come from. We've had the systems in place for 18 months and they've just about paid for themselves."

The direct electronic link Contex offers to Scitex also saves money. "Because we provide trade shops with electronic mechanicals that are much further developed, it takes less time. And here in New York City, Scitex time is very expensive."

Penrod's Group also uses the systems for the preparation of rough comps. "If we want to look at something in our internal grocery store, we comp up the design on the system and run out a thermal print. We wrap that around a carton and stick it on the grocery shelf. The time and effort saved in using that approach, as opposed to going through silk-screen comps or hand-finshed comps, is considerable.

"There is definitely a sense of power when you are using the system. And, because it gives us the ability to produce proofs that closely resemble the final printed package, there are fewer opportunities for errors.

"Precision is another major asset. The Contex systems provide more uniformity across a group of projects and across a brand. Once you get the first mechanical done as a master, the other ones just fly. And there's the same degree of accuracy on each job."

The design group doesn't have to worry about losing mechanicals either. Besides having their own electronic copy on file, the outside film separator has a backup.

"There's a quality issue here as well since the information is transferred directly to tape and doesn't diminish as you make additional copies."

"We feel we made a wise investment. And none too early," states Penrod. "Electronic design is here now and it is a necessity. It becomes a question of whether you pay up front and start reaping the benefits or wait until it's too late."

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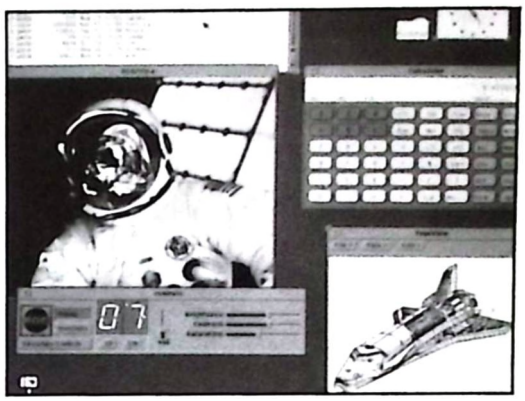

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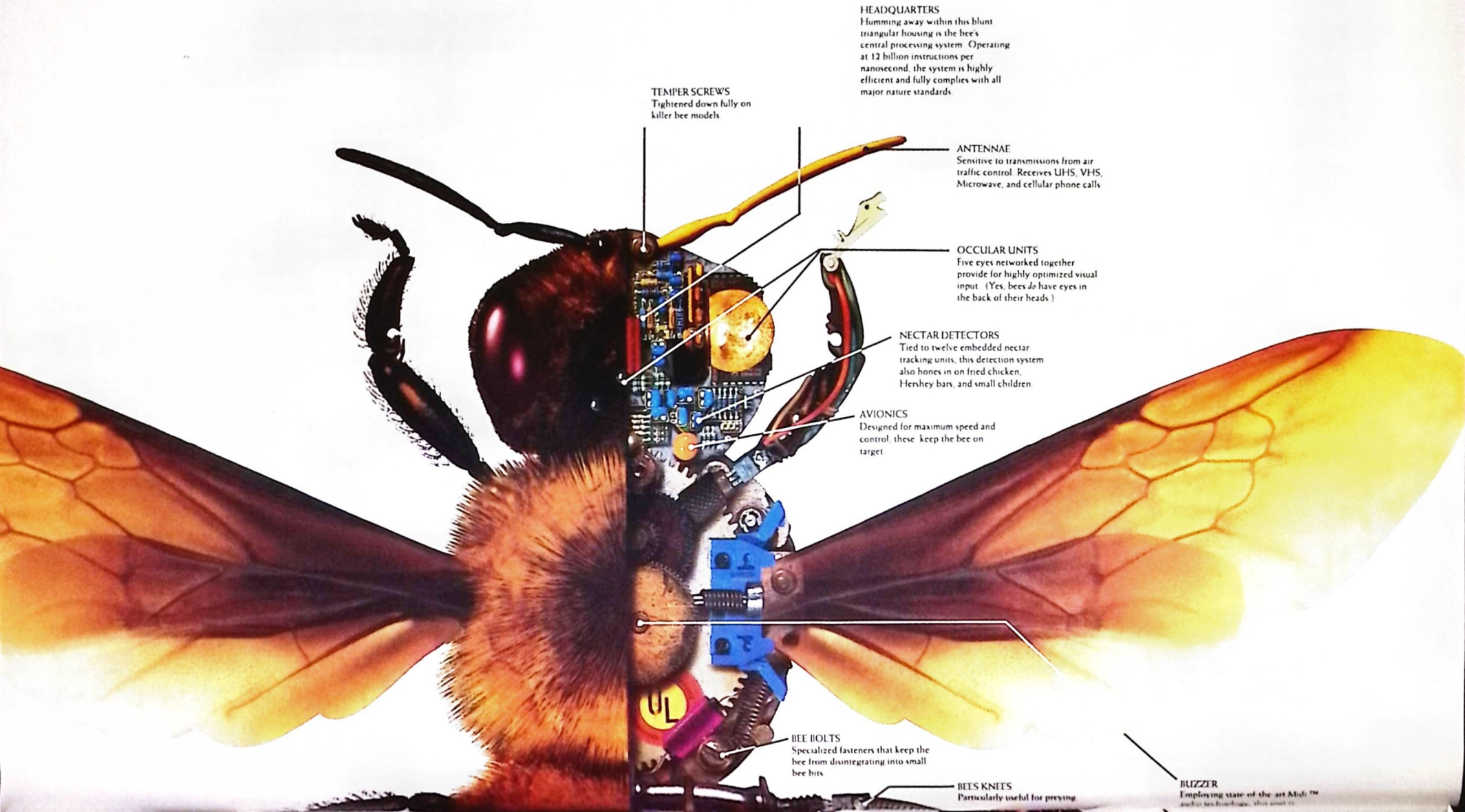
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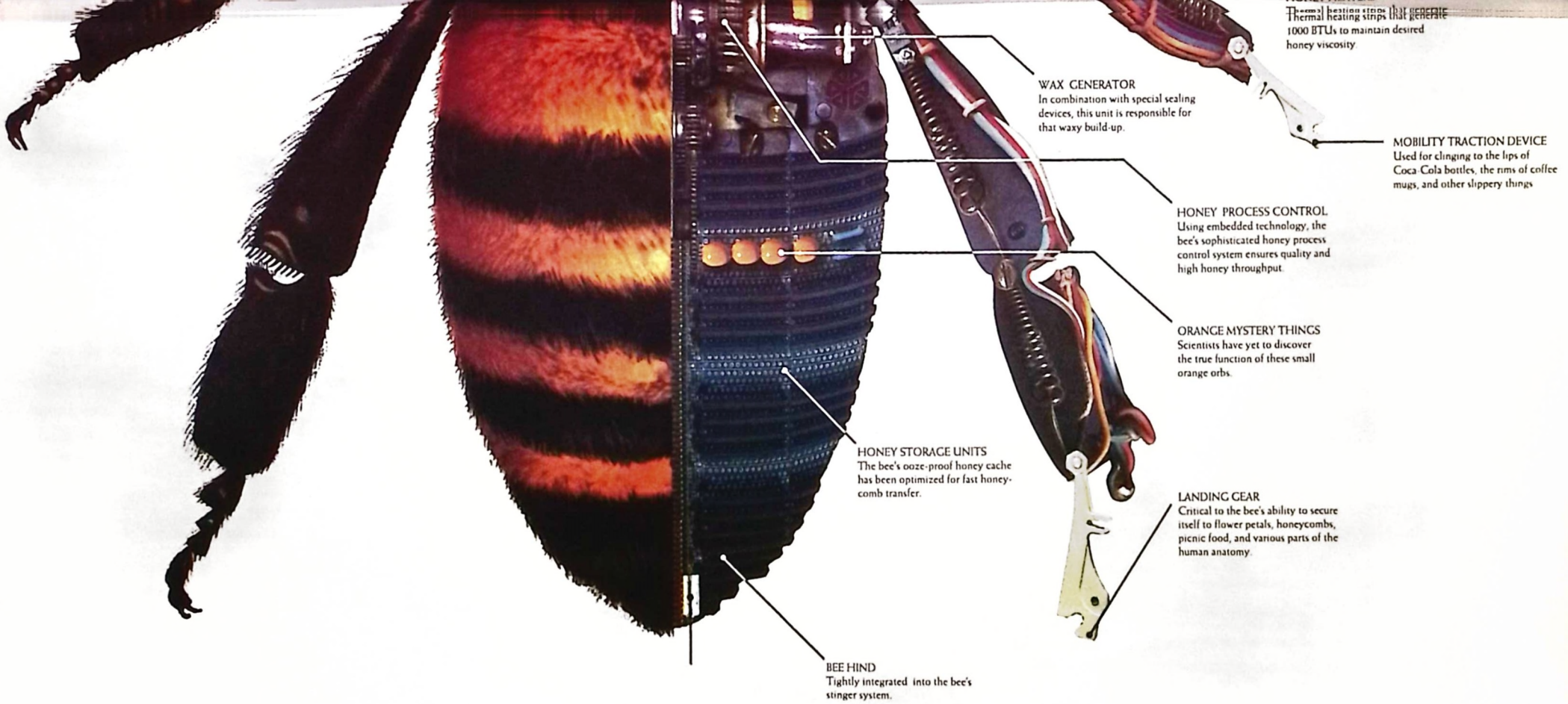
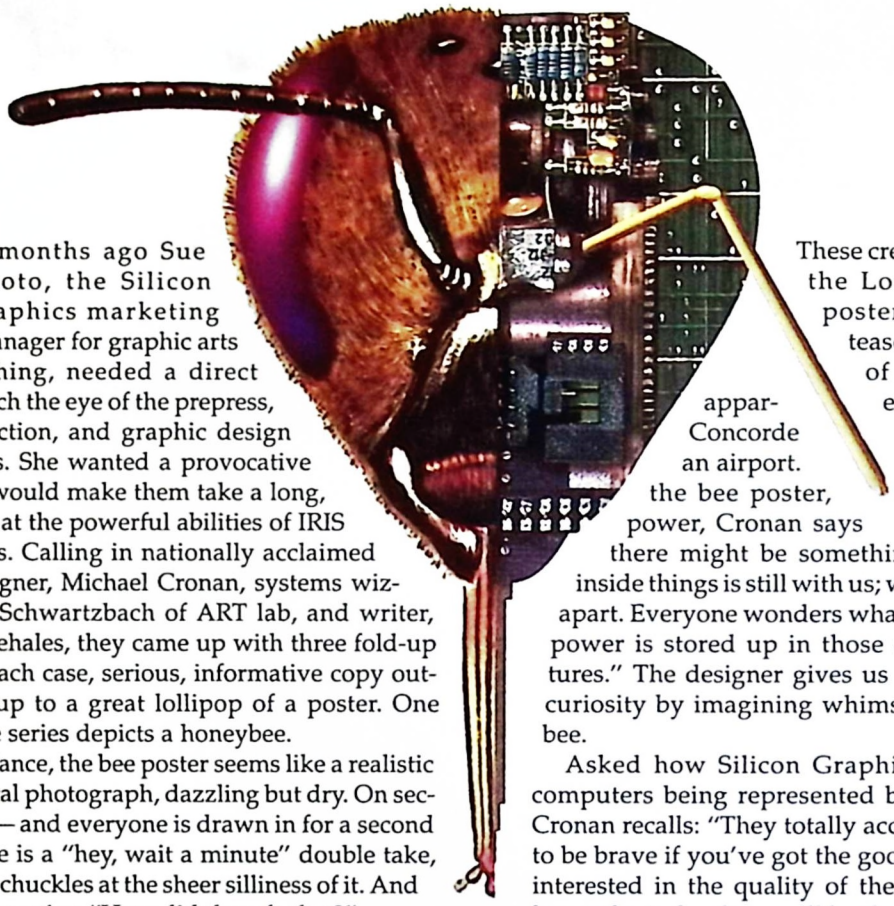
TEMPER SCREWS
Tightened down fully on killer bee models
ANTENNAE
Sensitive to transmissions from air traffic control. Receives UHS, VHS, Microwave, and cellular phone calls.
OCCULAR UNITS
Five eyes networked together provide for highly optimized visual input. (Yes, bees do have eyes in the back of their heads.)
NECTAR DETECTORS
Tied to twelve embedded nectar tracking units, this detection system also hones in on fried chicken, Hershey bars, and small children.
AVIONICS
Designed for maximum speed and control, these keep the bee on target.
BEE BOLTS
Specialized fasteners that keep the bee from disintegrating into small bee bits.
BEES KNEES
Particularly useful for preying.
BUZZER
Employing state-of-the-art Mids ™


Thermal heating strips that generate 1000 BTUs to maintain desired honey viscosity.
WAX GENERATOR
In combination with special sealing devices, this unit is responsible for that waxy build-up.
MOBILITY TRACTION DEVICE
Used for clinging to the lips of Coca-Cola bottles, the rims of coffee mugs, and other slippery things
HONEY PROCESS CONTROL
Using embedded technology, the bee's sophisticated honey process control system ensures quality and high honey throughput.
ORANGE MYSTERY THINGS
Scientists have yet to discover the true function of these small orange orbs.
HONEY STORAGE UNITS
The bee's ooze-proof honey cache has been optimized for fast honeycomb transfer.
LANDING GEAR
Critical to the bee's ability to secure itself to flower petals, honeycombs, picnic food, and various parts of the human anatomy.
BEE HIND
Tightly integrated into the bee's stinger system.
STINGER SYSTEM
This hydraulic delivery mechanism serves as the bee's main weapon system. Studies show that the stinger system releases over 12,000 PSI of nasty substance upon impact. The average bee sting injects approximately 17 quarts of venom.

The amazing story of how the efforts of a designer, a computer graphics wiz, talented technicians, and powerful technology all came together to invent a honeybee that never was.

BY ANNE TURLEY

HEAD OF STATE
The queen bee rules the hive and has all the fun. Characteristics: domineering, mean, volatile, seductive, ravenous, and prolific.



A few months ago Sue Egnoto, the Silicon Graphics marketing manager for graphic arts and publishing, needed a direct mailer to catch the eye of the prepress, print production, and graphic design communities. She wanted a provocative mailer that would make them take a long, serious look at the powerful abilities of IRIS workstations. Calling in nationally acclaimed graphic designer, Michael Cronan, systems wizard, Robert Schwartzbach of ART lab, and writer, Crispin Littlehales, they came up with three fold-up posters. In each case, serious, informative copy outside opens up to a great lollipop of a poster. One poster in the series depicts a honeybee.

At first glance, the bee poster seems like a realistic entomological photograph, dazzling but dry. On second glance — and everyone is drawn in for a second look — there is a "hey, wait a minute" double take, followed by chuckles at the sheer silliness of it. And finally, the question "How did they *do* that?"

The story of "how they did that" includes some unusual snapshots (in color, naturally) of dedicated artists and technicians at work: trying to uncurl dead bees, using fuzzy bathroom rugs to simulate bee fur, photographing a virtual junk shop of spare bee parts, tormenting electronic images far beyond the legal limit by squeezing, stretching, bending, twisting, and yes, even cloning. And then, there is a priceless group shot of the self-proclaimed bee experts pontificating over the identity of the greater and lesser parts of the bee; "Those are the honey heaters! No, no. That's the stinger system there. Then where's the buzzer?"

Designer Cronan follows a straightforward formula for all his work: it has to appeal to both the head and the heart, simultaneously and in equal measure. He points out that "We cherish our kidhood feelings. Tapping into them in a gentle way is a very positive thing. It doesn't demean what you're trying to present if you do it with enough sensibility and kindness."

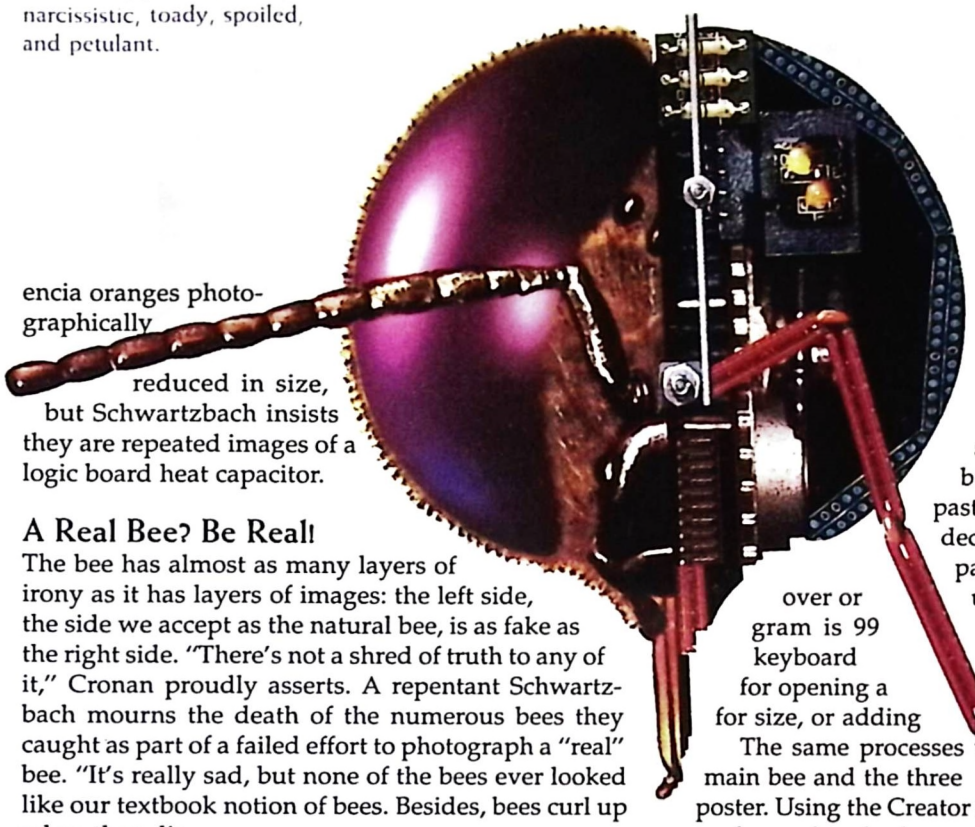
Each poster in the series is a visual conundrum. Textbook realism combines with magnificent images that poke gentle fun at our perceptions of reality. The first poster, a metaphor for color, puts a spin on the idea of camouflage by showing a textbook arrangement of butterflies with unexpected artwork on their wings. These creatures could hide in the Louvre. The second poster, titled "Vision," teases us with a change of scale; a dragonfly apparently the size of the Concorde about to take off at an airport. In the case of the bee poster, the metaphor for power, Cronan says "the thought that there might be something quite surprising inside things is still with us; we love to take things apart. Everyone wonders what kind of energy and power is stored up in those dynamic little creatures." The designer gives us back our childhood curiosity by imagining whimsical guts inside the bee.

Asked how Silicon Graphics felt about their computers being represented by a bunch of bugs, Cronan recalls: "They totally accepted that. It is easy to be brave if you've got the goods. They were more interested in the quality of the ideas because they know the technology will be there."

## The Truth About Orange Mystery Things

The task of photographing objects to fill out the artist's sketch fell to Robert Schwartzbach, Cronan Design, and San Francisco photographer Gerry Bybee of the Bybee Studio. "Many people thought we built a model, then photographed it," comments Schwartzbach. "No, it was all hundreds of little parts photographed separately and put together electronically on a Silicon Graphics GTX workstation using Barco Graphics' Creator 500 package." The right side of the bee combines cutouts from photos of digital, mechanical and synthetic parts. Scanning down from the top, the original parts that remain identifiable include a conglomeration of logic board circuitry with the encrusted light bulb from a tabletop juke box treated as the bee's "Occular Unit." A capacitor from a logic board was distorted to form the antenna. The gears in the thorax once served in record players and an old clock. The UL label once graced an iron. Schwartzbach reminisces about a trip to an electronics store where "We dug around in an old box and picked out stuff that looked interesting." Clips that hold the logic board in place form the Landing Gear at the ends of the legs. And the Orange Mystery Things? Someone tried to claim that they were Val-

GIGOLO
The drone bee makes a living off the queen. Characteristics: oversexed, presumptuous, narcissistic, toady, spoiled, and petulant.



encia oranges photo-
graphically
reduced in size,
but Schwartzbach insists
they are repeated images of a
logic board heat capacitor.

## A Real Bee? Be Real!

The bee has almost as many layers of irony as it has layers of images: the left side, the side we accept as the natural bee, is as fake as the right side. "There's not a shred of truth to any of it," Cronan proudly asserts. A repentant Schwartzbach mourns the death of the numerous bees they caught as part of a failed effort to photograph a "real" bee. "It's really sad, but none of the bees ever looked like our textbook notion of bees. Besides, bees curl up when they die.

We spent a long time trying to uncurl bees, getting bee parts photographed and it never really worked." The artist confirms the curious problem of representing reality, observing that "every realistic photograph requires some degree of bending of the laws of physics and reality to make it look real," thus confirming the old art historian cliche that naturalism, too, is a form of convention.

To establish the illusion of a real bee, Cronan and company used an illustration supplied by English beekeepers. They augmented it with photographs of separate bee parts and some unlikely elements such as a bathroom rug to bring the bee's fur up to expectations. A housefly supplied the "bee" wings.

## Now the Fun Begins

Once the photographs were taken, they went to the designer as color copies that could be cut and pasted onto acetate sheets. Meanwhile, the original full sheets of transparencies were electronically scanned into data files by San Francisco's Repro-Media using a Crosfield scanner. The data files were then passed to the Barco Graphics BG-Creator 500 on a Silicon Graphics GTX workstation located at Barco Graphics in Dayton, Ohio. There, Barco Graphics operator Peter Loft and Schwartzbach settled down for the real fun.

Using the English bee illustration as a template, they eliminated the right half and made an area of color with the line artwork module, throwing in a gray tint to

delineate it. Then they started building on top of it, eventually covering up the gray background on the right side. Pressure sensitive stylus in hand, Loft began the detailed cut-and-paste process which he likens to decoupage, "except that in our package you can stick things under." The Creator program is 99 percent stylus driven; the keyboard remains untouched except for opening a file or entering a number for size, or adding text.

over or

The same processes were repeated to create the main bee and the three heads at the bottom of the poster. Using the Creator system's modular functions, nearly one hundred separate pieces were cut, layered, painted, warped, masked, and given shadows and highlights to simulate a single source of light.

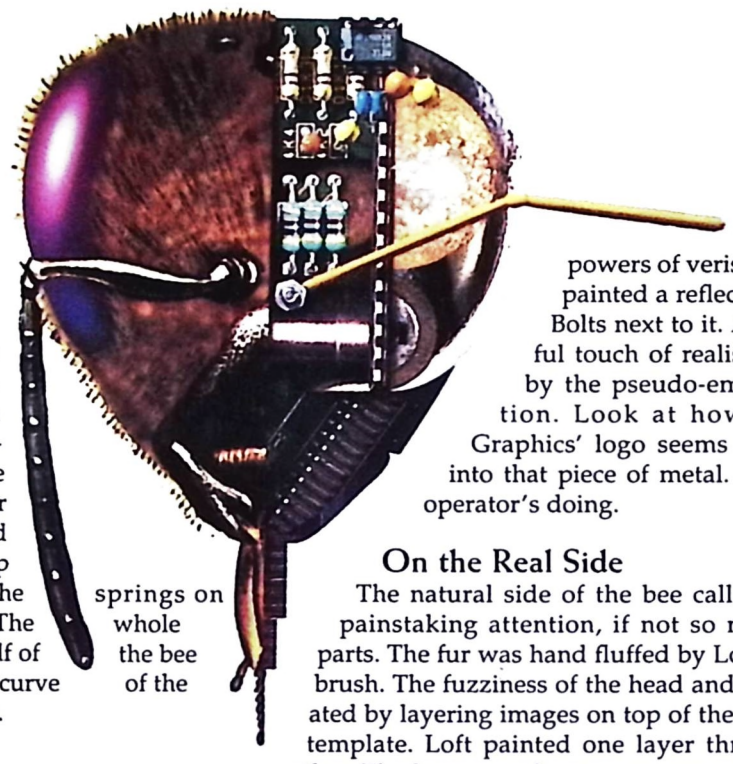
## Sticking on Decals

Cutting and pasting was the basic maneuver for many images. For instance, wielding the stylus like a penknife, Loft would incise a square cutout around a gear. Then, using the stylus as an eraser to nibble away at the unwanted portions, he would isolate the fine-toothed gear until it stood alone on an apparently black background. "The gear becomes like a decal," Loft comments. "I can paste it down over anything."

## Approaching Warp Speed

The warp function added perspective and depth to individual parts as well as whole sections of the bee. Anamorphic distortion is the correct name but Loft likes to call the warp function "stretch and squeeze." He explains that this feature allows you to interpose any cutout over an arbitrary grid pattern offering as many grid control points as you want. "As you move the grid pattern, the image has to follow, rather like placing your cutout on a piece of rubber or balloon and then stretching or inflating it. We can do this while maintaining the extremely high resolution of the image." As you stretch and squeeze, the image instantly changes on the screen, just as when you use the paint function, you immediately see the colored brush strokes.

PROLETARIAT
All work and no play gives the worker bee a dull buzz. Characteristics: subservient, busy, dull-witted, unimaginative, and whiney.



The yellow antenna, once a logic board capacitor, was stretched and bent to resemble a feeler, then, for an encore, it was straightened, shrunk and used as the small vertical yellow piece in the head. Likewise, the screw, visible through the wing, is the same screw Loft used on the right rear leg, only it was bent and twisted as he pasted it down. The warp pasting function also stretched the springs on the legs and curved the wires. The whole lower third of the mechanical half of the bee was gently sculpted to mirror the curve of the "real" striped bee fur opposite it.

## Behind the Mask

Masking was another means for manipulating parts and special effects, such as where shadowing was added to provide a greater sense of realism. Loft masked areas to be shadowed. The shadows were painted in after the bee bits were in place, giving them realistic depth. You see an example of semi-transparent masking, which allows an image to be placed over a softly masked object in order for a portion of the lower image to show through, when you notice how the wing fits into the blue mechanical part. The bolt is visible through the wing.

## Winging It

The wing, indeed, posed some special problems. To begin with, there was only one wing photo and it showed a rather ragged, beat-up wing. The image had to be patched up, neatly trimmed, rendered transparent, and also duplicated via pixel transfer, a process also known as image cloning. Image cloning was also used for the repetitive pattern of the lower third of the bee. "We took a group of memory chips and repeated the image many times as a sub-image before warping the whole area," recalls Loft. The Orange Mystery Things were cloned from a single heat capacitor.

Loft and Schwartzbach had to wing it with synthetic constructions when the designer asked for even more parts. The shiny magenta capacitor, for instance, was made with the software's three-dimensional module. It bears the names of its creators. Loft, carried away by his powers of verisimilitude, also painted a reflection of the Bee Bolts next to it. Another graceful touch of realism was added by the pseudo-embossing function. Look at how the Silicon Graphics' logo seems to be pressed into that piece of metal. That is all the operator's doing.

## On the Real Side

The natural side of the bee called for equally painstaking attention, if not so many separate parts. The fur was hand fluffed by Loft's digital airbrush. The fuzziness of the head and body was created by layering images on top of the illustrated bee template. Loft painted one layer through into the other. The large purple eye was composed on the 3D module and then brushed into place.

When the bee was as chock full of realistic parts as it could possibly be, the files were returned as nine-track tape to Repro-Media for UCR, the creation of black separations, and final file processing for proofing and match prints.

## Bee Power

The bee represents power that exceeds the sheer horsepower of the underlying platform, which the bee symbolizes for the artist. The bee poster is an emblem of this new power and the evolving relationship between artist and electronic technology. Michael Cronan explains this new attitude by inverting Goethe's aphorism that "Architecture is frozen music" to "Music is liquid architecture." He goes on to explain his view, saying, "There are many ways in which music and architecture are analogous. There's scale, there's theme, there's transition. You can imagine wonderful auditory architects composing fabulous pieces of music and conversely, you can see composers composing static sonatas. Now to me, the architecture involved in computer technology renders this architecture absolutely liquid, absolutely transparent, absolutely accessible to all of us. So, in a lot of ways computer technology is now becoming liquid architecture. We are able to add and move huge volumes of computer space, effortlessly and without any troubling limitations. I think the possibilities are fascinating."

---

*Anne Turley is a freelance writer in San Francisco.*

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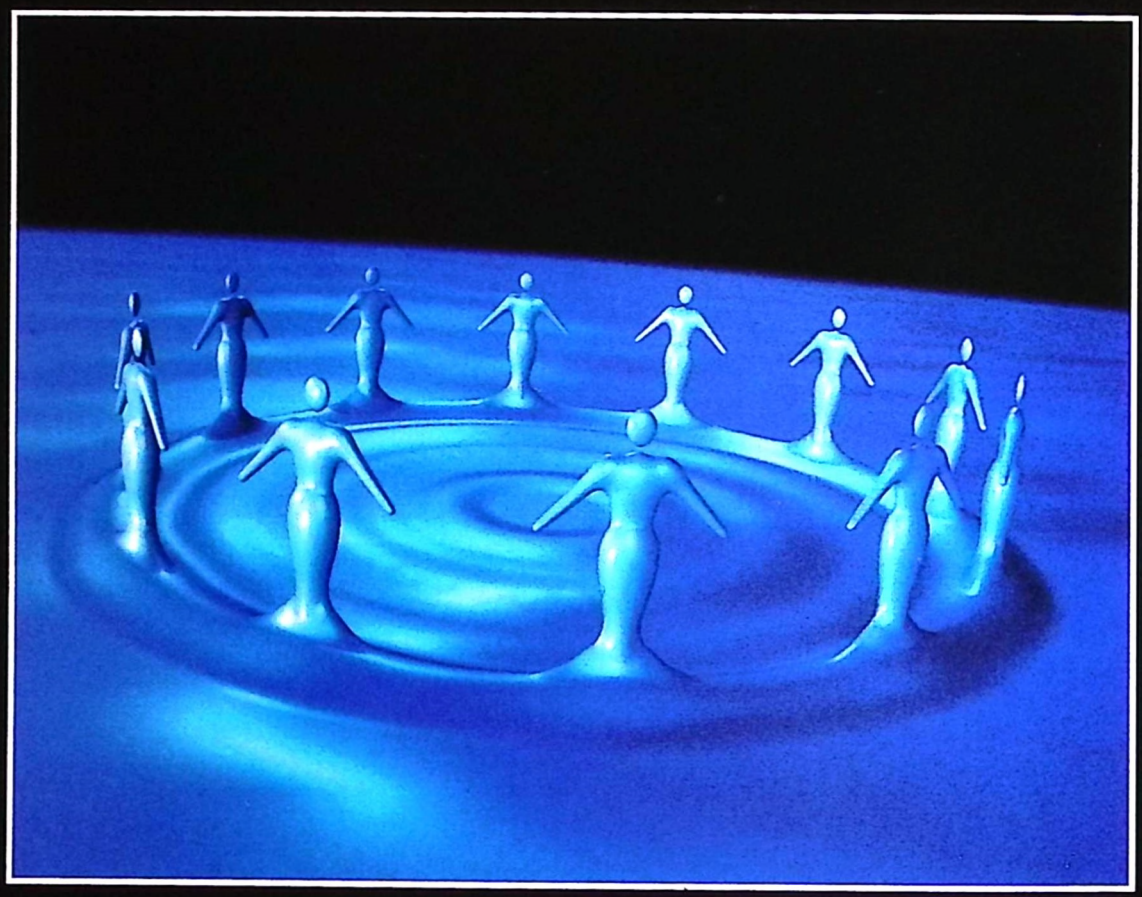
# *The Dancing Crown of Milk*

## VISUAL PROCESSING IN THE LAND OF THE RISING SUN



*A unique animation program called Metaball is based on the digital equivalent of liquid mercury.*

BY CRISPIN LITTLEHALES WITH HIROSHI IGUCHI

Upon viewing the demo reel of a Tokyo-based computer graphics/video post production company called LINKS Corporation, I was struck by the unique quality of certain animated sequences. One in particular caught my eye—a TV monitor flies into the distance, drops into a sea of milk and emerges as a crown of liquid which then transforms into a circle of dancing human forms "How," I asked myself, "did they do that?"

The great mystery was resolved a few days later when Hiroshi Iguchi, a LINKS representative who is also an accomplished computer graphics artist, arrived at my office. The answer, as he was to demonstrate, is Metaball.

Metaball is a computer graphics primitive that behaves like a droplet of mercury in three-dimensional space. Every miniscule sphere distributes density gradually from its center to the circumference And each tiny ball — yes, each *meta*ball— may be created with its own unique attributes (color and texture mapping). Like mercury, these round shapes fuse together as they move toward one another. As the balls blend, so do their shapes, colors, and textures, delivering both a smooth curve and a smooth gradation.

Hundreds of metaballs with different attributes can be fused to produce very complex shapes. About 500 are required to fashion a human body, whereas each of the figures in the milk crown were made from just fifty.

The Metaball program has several characteristics that allow the animator to create unique visual sequences. The smooth curved surface of the metaball provides a decided visual advantage over polygonal curved surfaces, and demands far less memory. Moreover, the program's ability to transform shapes and textures makes it possible to animate liquid flow. LINKS Corporation's production team has used Metaball to form human figures from such substances as sea water, shampoo foam, milk, gold, and silver.

Animating with Metaball does present some challenges. First, the Metaball program is difficult to handle — again, rather like mercury. Accordingly, a modeling package named META EDITOR™ (META Corporation, Japan) has been developed for editing metaball primitive data, enabling the user to interactively create, check, and modify metaball data by viewing the blended results of metaballs as contour lines in three views. Metaball also requires time-intensive rendering. The production department at LINKS uses two Silicon Graphics 4D/70G workstations exclusively for this purpose. Two 4D/25TG systems are also used in the production department as design workstations.

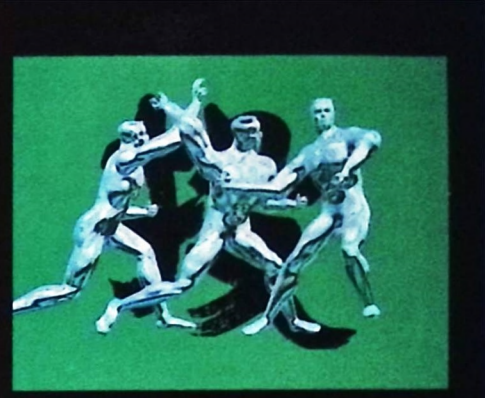
## *The Urge to Merge*

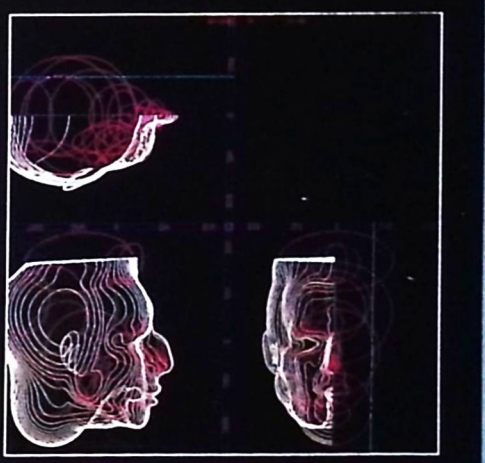
As mentioned previously, metaball has its own density distribution field. The center of the metaball sphere has a maximum density, which gradually diminishes as it approaches the circumference. The value of density in the center of the circle is called "weight," and the boundaries of the density field, where the density value is zero, is called "effective radius".

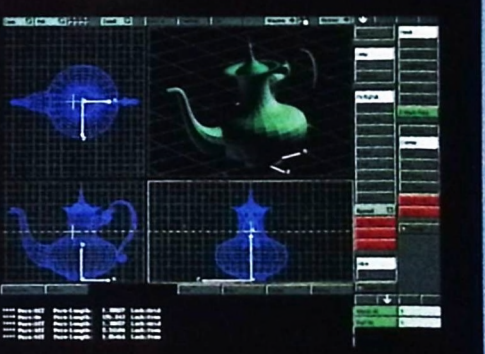
The apparent size of the metaball, called the "threshold radius," is determined by the effective radius and the weight of the sphere. The user need only choose two out of those three qualities of the metaball. The third is automatically determined.

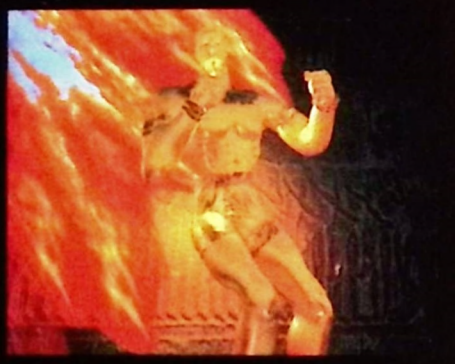
Before the specification, the user must choose between the threshold radius and the effective radius. The effective radius indicates the area of the density distribution of the metaball. The actual radius visible (the threshold radius) becomes smaller when rendered. As the weight becomes greater, the threshold radius also grows and converges on the effective radius. On the other hand, if the weight diminishes, the threshold radius becomes smaller accordingly.

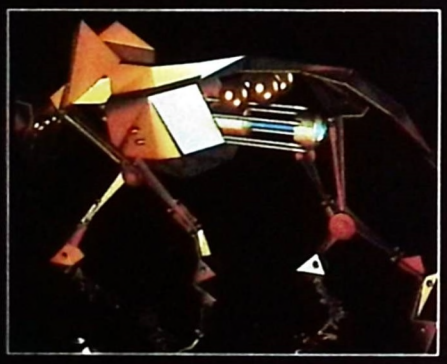
Inversely, the user can specify the











apparent size of a single metaball by determining the threshold radius. When the effective radii of more than two metaballs overlap, the size of each becomes bigger than the threshold radius. When the threshold radius is specified, the effective radius changes as the weight changes. As the value of the weight becomes smaller, the effective radius becomes greater and is more influenced by other metaballs. This is the state where a metaball is most likely to change its shape.

If, on the other hand, the weight becomes greater, the effective radius becomes smaller and less likely to be affected by others. Under these circumstances, the metaball becomes "harder". Weight designates the influence a metaball has on its neighboring metaballs. Even if the effective radius remains the same, the size of a newly created shape becomes larger as its weight grows.

When the user specifies a negative weight value, a negative metaball is created. The negative metaball does not appear, but it will react against positive metaballs and thus can be used as a counter force. The conditions under which this occurs are the same as those that prevail when positive metaballs are joined.

To merge the attributes of two or more metaballs, the user must turn on the program's "fusion" function. All the attributes of the colliding orbs, such as color, transparency, and the like are merged, using the weight of the resulting metaball as the parameter. Using this function, it is possible to create non-existent objects by merging a metaball with the characteristics of glass with a metaball that has the characteristics of metal. If the fusion command is not specified, the characteristics of the merging metaballs won't blend, but, rather, will butt up against one another at the point the balls join.

## *The Origin of Metaball*

The idea of creating 3D shapes using metaballs originated in research performed in 1982 by Hitoshi Nishimura, now president of Nishimura Research Laboratory. At the time, Nishimura was a student in the masters program at Osaka University (coincidentally, noted U.S. computer scientist Jim Blinn was toying with similar ideas at about the same time). Users working with the first version of Nishimura's software found it difficult to specify and edit the smooth, complex, curved forms. Another Osaka University student, Eiji Takaoki, currently president of META Corporation, Japan, solved the problem by developing the Meta Editor for visualizing a metaball's topography.

## *The LINKS Link*

In addition to its role in computer graphics and video post production, LINKS Corporation develops and markets software. The company's Personal LINKS computer graphics/animation software system produces photorealistic images for entertainment, industrial, advertising, architectural design, and simulation applications. LINKS first adopted the Metaball program as a production tool and has since incorporated it into the Personal LINKS system.

Interestingly enough, the company's history is intertwined with the emergence of computer graphics technologies in Japan. In 1979, film director Mataichiro Yamamoto met with Koichi Ohmura, a Ph.D. at Osaka University. Both were intrigued by the computer graphics technology gaining popularity at the time in the American film industry. Once they became aware of their mutual interest, Yamamoto and Ohmura agreed to collaborate on the research and development of similar technology for use in the production of videos.

Meanwhile, Far East Laboratory, the largest film processing and video development company in Japan, was looking

for a way to utilize computer graphics to develop a new imaging technology. Since Osaka University was the only institution researching the problem, Far East Laboratory joined Yamamoto and Ohmura in their endeavor.

At first, the group thought the only way to produce the kind of high-quality, ray-traced imagery they wanted would be to employ a high-speed supercomputer. To get around this, Ohmura suggested using parallel processing architecture — an innovative notion at the time. In 1982, Osaka University built the first of these systems, the LINKS - 1, and shortly thereafter Far East Links was born.

Many students from the University moved to Far East Links to assist in the maintenance and enhancement of LINKS-1 and the development of LINKS-2 — a more powerful system using custom LSI technology. In 1985, Far East Laboratory changed their company name to IMAGICA and Toyo Links changed its name to LINKS Corporation. Three years later, LINKS became a wholly owned subsidiary of IMAGICA.

As the two companies altered their identity, they also changed the structure of the company. IMAGICA established an integrated research laboratory for developing new imaging technologies, into which all the engineers from LINKS could be received. Meanwhile, the expanding LINKS business was organized into three departments: Production, to handle video and film production; Sales, to market 3D computer graphics software; and Operations, to ensure efficient functioning of the system.

LINKS also offers a video production service analogous to the developing, printing, and enlarging services widely offered for still photography. Thus, customers bring data produced using a Personal LINKS system (often based on Silicon Graphics hardware) to the company's Image Factory, where it can be rendered into stills and 3D animation sequences using texture mapping, ray tracing, and other resource-intensive algorithms. Output can come in the form of video, slides, or print.

The company introduced its Personal LINKS software in 1987. The Personal IRIS is the most popular workstation running the software, and the company uses Silicon Graphics hardware to run customer demos. The IMAGICA computer graphics development laboratory uses a 4D/320VGX workstation and two 4D/25TG systems for software development.

Currently, thirty-four of LINKS' fifty-three employees work in production. The company plans to continue the development of Personal LINKS technology, including the integration of various modules and improvements to the user interface. Once these goals have been realized, LINKS plans to develop market-specific turnkey presentation systems, using image library databases (including a complete system for creating architectural renderings with libraries of design elements such as room shapes and furnishings).

The people of LINKS believe that imagination lets one move freely through time and space. Viewing the work done using Metaball technology is a good indication of what such freedom can yield, and the limitless possibilities for its future.

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*Crispin Littlehales is Associate Editor of the* IRIS Universe. *Hiroshi Iguchi is a computer graphics artist and a representative of LINKS Corporation in the United States.*

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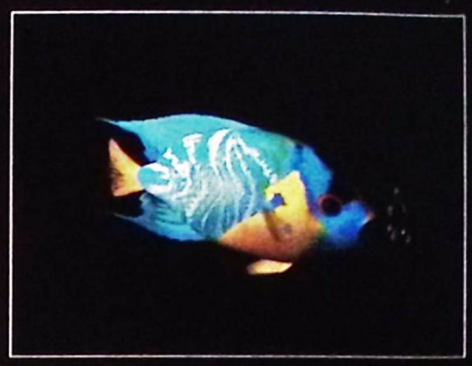
*For more information about Metaball please contact: LINKS Corporation, 3-13-6, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140, Japan, Tel: 011-81-3-3450-8181, Fax: 011-81-3-3471-2607.* ●



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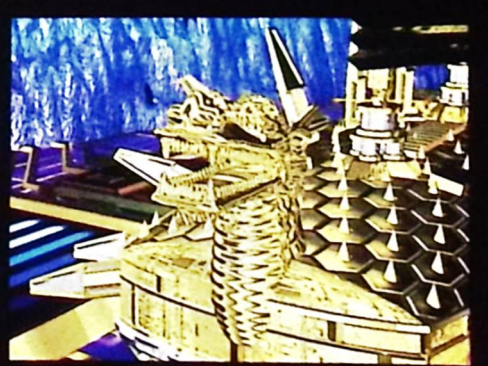


*"By offering a highly visual and reconfigurable environment, Singapore Aerospace's system designers can explore all possible solutions with their customers in a much shorter time and come up with the optimum product."*

tactical environment — including threat aircraft — is simulated using four IRIS workstations. A DEC VAX 6310 computer supports the embedded software development environment.

The AIL is able to identify potential problems relating to functionality and design early in the product development cycle. A customer can actually envision the operational environment specifications and evaluate the new system at once, thus minimizing the chance of implementing the wrong strategy. By offering a highly visual and reconfigurable environment, Singapore Aerospace's system designers can explore all possible solutions with their customers in a much shorter time and, ultimately, come up with the optimum product.

### *A Closer Look at the Cockpit Development Station*

Configured to emulate the cockpit of the target aircraft, the CDS facilities within the AIL speed up the designer's ability to prototype the desired cockpit layout and operational flight procedure. The latter involves the implementation of the logic behind the multi-function display (MFD) pages, the up-front controller panel (UFCP) keys, the moding logic, and the hands-on-throttle-and-stick (HOTAS) switches. A real-time operating system and programming language is essential in order to simulate an on-line response identical to the aircraft environment. The designer uses graphics and simulation tools to draw and animate the instrument displays. Design verification is accomplished through the use of a pilot interface unit that allows the pilot to perform touch and feel tests on the position and the size of the instrument displays. The hardware is visualized using computer graphics displays with touch screen overlays.

A Silicon Graphics Power Series 4D/220 GTXB workstation and Personal IRIS 4D/25TG and 4D/20G computers are used for the CDS simulation. The 4D/ 220 GTXB system hosts the out-the-window (OTW) display, the tactical simulation software, and the sensor simulation software. The 4D/25TG workstation is used for cockpit instrument display and the 4D/20G system is used for the instructor station, since real-time response is not a critical requirement in this area.

### *Simulation Software*

Two off-the-shelf software packages running on the Silicon Graphics' platform; the Tactical Environment Generator (TEG) and the Avionics Prototyping Software, are used for simulation. TEG, a flight simulation program, is used for the cockpit's animation dynamics and to create the external environment of the cockpit during flight. It can simulate the enemy aircraft location and compute its response based on the scenario set up by the user. TEG also provides real-time dynamic operational environment specifications (ORS). A special recording feature has been added, making it possible to replay the same scenario while the test pilot uses a different ORS in the flight. TEG runs consistently at 20 Hz or 50 msec cycle time. In each cycle, the aircraft's dynamics and the avionics are being calculated for all simulated objects. Communication between the various simulation software is accomplished via an Ethernet network and a high speed parallel communication board. This capacity to handle real time events makes it possible to deliver spontaneous responses to pilots. Thus, the immediate advantage of each ORS can be compared directly.

The Avionics Prototyping Software is a rapid prototyping tool that enables the designer to draft ORS implementation. The program facilitates the production of a graphical display such as the instrument panel and the MFD menu pages. It also allows intelligence to be incorporated into the graphical display. For example, it can swap menu pages when the bezel keys on the MFDs are selected. Integration of logic and graphics is accomplished with an integration mod-

ule to produce an animation of the display copy in an executable form.

### *Pilot Interface Environment*

The pilot interface environment consists of the flight controls, including the stick, throttle, HOTAS switches, and the optional rudder pedals. A dedicated A/D box transmits the signals back into the simulation computer through the VME panel. To give pilots the most realistic testing situation possible, the entire interface environment is housed in a cockpit mockup that closely resembles the nose of the actual aircraft.

### *Cockpit Display Systems*

Two display systems are used in the CDS; an out-the-window (OTW) display and a virtual instrument display system. The OTW, which is part of the TEG software package, is projected onto a diagonally curved screen ten feet in width and furnishes visual cues of the outside world to the pilot/engineer during the evaluation. The field of view is 45" x 45" at present, however, Singapore Aerospace plans to enhance the current system with texturing features and expand the viewing field to three screens.

The virtual instrument display consists of a projected image of the cockpit layout implemented by VAPS Designer. For a realistic feel of the cockpit, the display affords rear projection comprising a high resolution, close focus projector and projection screen cut into the shape of the instrument panel.

### *Instructor's Station*

Serving as the central control of the simulation operation, the instructor's station allows the instructor or control personnel to perform scenario setup, simulation monitoring, and scenario freeze or replay throughout the simulation.

Scenario setup may encompass the following:

- Position of aircraft and external threats
- Aircraft configuration (weight, fuel, etc.)
- Environmental conditions
- Flight plan
- Weapon configuration

To ensure that the instructor has a bird's eye view of the whole battle scene in three dimensions, the station has a scenario monitor capability. The instructor can stop and replay the scene whenever the simulation needs adjustment.

A scenario freeze feature enables the instructor to suspend the computation of all simulation programs so that test conditions (eg. amount of fuel) or tactical situations may be altered before continuing the simulation.

### *Future Directions*

Over the last six years, Singapore Aerospace's engineering resources and skills have grown more than ten fold. As mentioned previously, the company is in the process of completing the AIL and improving its integration capabilities and facilities. A brief description of each of the other sections of the laboratory follows.

*The Software Development Station* is a multi-user environment for programmers to implement the embedded software. High level, real-time programming languages, software performance analysis tools, documentation production tools, and program testing tools are available. In addition, an emulator is used for cross compilation of the programming code into the embedded software code.

*The Test and Integration System* is something of a system rig consisting of cabinets and bays for housing the aircraft sub-systems, interface adaptors, patch panels, monitors, a simulator console panel, standard laboratory test equipment, and test fixtures required for the integration testing. The System supplies the engineering facility for integrating major avionics subsystems with real or simulated sensors that are interfaced to the aircraft. Thus, the complete avionics baseline system can be tested and verified independently prior to installation. By using a mix of both actual line replaceable units (LRU) and sensor simulation modules, verification is possible without full delivery of the system hardware.

*The Cockpit Trainer* enables pilots to familiarize themselves with the new cockpit and avionics system. Because its requirements are very similar to those of the CDS, the Cockpit Trainer can be evolved directly from the CDS at minimal cost. The conversion involves the replacement of the reconfigurable virtual panel with the actual airborne hardware. Simulation tools such as mission debriefing and the playback element from the TEG are also utilized. As a result, pilots in training may view the battle scene from any angle in three dimensions, or from the enemy's cockpit. This capability helps the trainee to recall his weak points or mistakes.

While Singapore Aerospace will continue to concentrate much of its efforts on the aircraft upgrade market and the strengthening of its AIL, the company hopes to diversify into the low-end aircraft simulator business. To this end, Singapore Aerospace plans to develop F5 trainers that will be bundled together with its upgrade program. The AIL's visual database is being modified to accept DMA data thereby enabling the generation of three dimensional, fully textured objects. Silicon Graphics will remain the platform for all future developments in the simulation area.

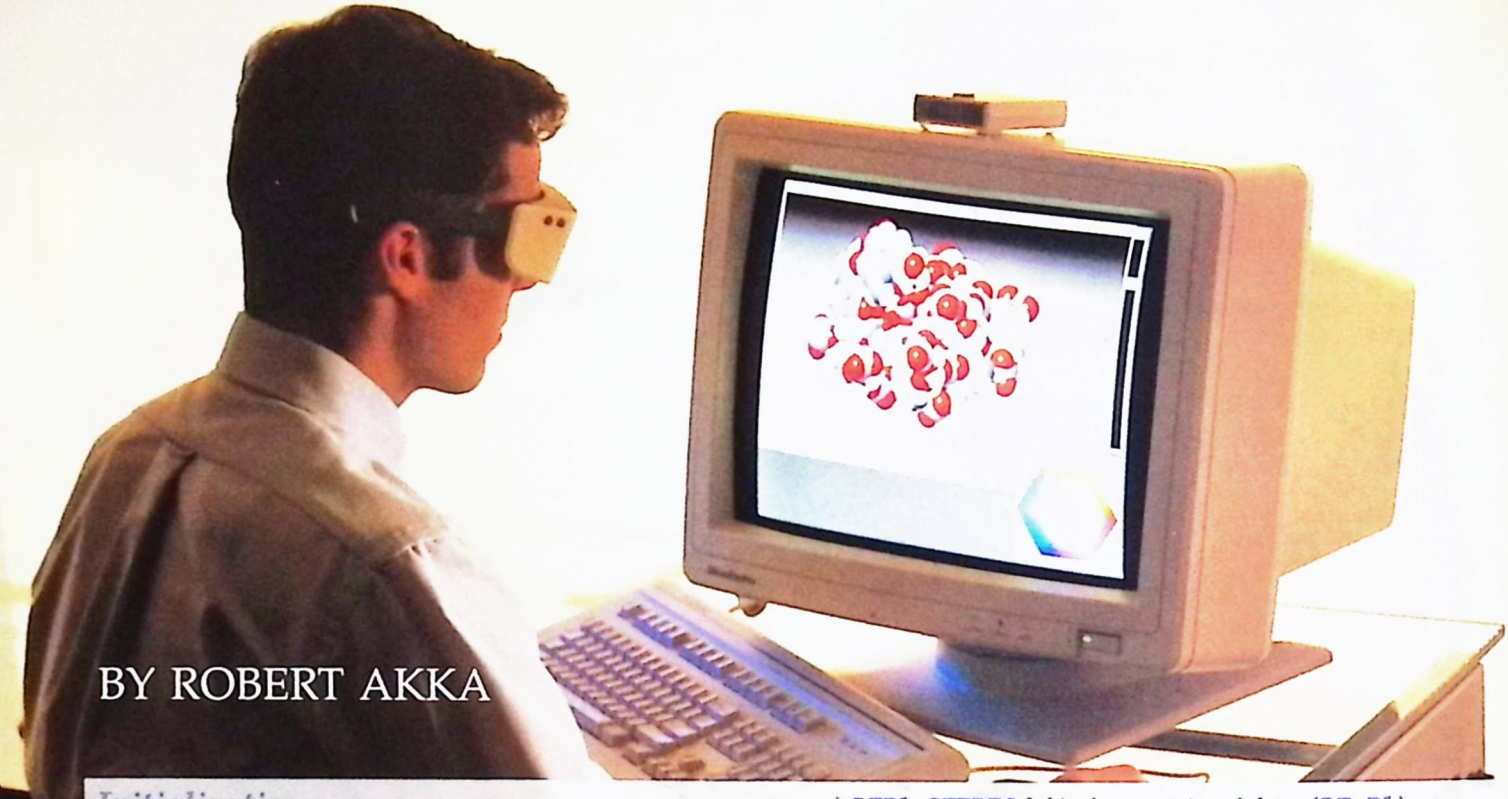
The Avionics Integration Laboratory is still a relatively new way of engineering technologically advanced integration systems in Asia and in much of the rest of the world. As both the creator of the AIL and the leader in the field, Singapore Aerospace believes that it is in an ideal position to meet the market demands of tomorrow.

---

*Margaret Long, Y.H., works in the Engineering Development Center of Singapore Aerospace. David Soh is Marketing Manager for Silicon Graphics, Singapore.* ●

# Writing Stereoscopic 3D Graphics Software Using the IRIS Graphics Library

*True depth perception occurs when each eye sees the world from a slightly different perspective. Our minds fuse these two images into a single stereoscopic image. In the case of computers, the software itself generates the left and right perspectives.*



BY ROBERT AKKA

## *Initialization*

Stereo applications must run in a full-screen mode. To accomplish this, simply open the window to fill the screen (note: if system is previous to IRIX 3.3, replace `getgdesc (GD_XPMAX)` and `getgdesc (GD_YPMAX)` with `XMAXSCREEN` and `YMAXSCREEN`, respectively):

```
prefposition (0, getgdesc (GD_XPMAX), 0,
   getgdesc (GD_YPMAX)); winopen ("") ;
```

One of the first things that a stereoscopic graphics application must do is make sure that the hardware is stereo-ready, and if so, make the hardware call to double the screen refresh rate, and activate the infrared synchronization signal. Before changing the monitor mode, save the current one:

```
long monitor;
monitor = getmonitor ();
```

Now, check the hardware, and go into stereo mode:

```
if (is_stereo() )
  setmonitor(STR_RECT) ;

int is_stereo(void)
/*
* Use this version of is_stereo () for IRIX 3.3
* or later. For older systems, you will instead
* need to write a routine that checks the
* DER1_STEREO bit (use get_video (DE_R1)
* to obtain the long int containing this bit) to
* see if it is alterable. If this bit is
* read-only, then the system is stereo-ready.
*/
{
  return (getgdesc (GD_STEREO));
}
```

What the program ought to do if the hardware is not stereo-ready is up to the application designer.

The monitors of all stereo-ready Silicon Graphics machines have a vertical resolution of 1024, and a vertical blanking interval (`YBLANK`) that is 41 pixels thick. Thus, the height of each stereo subfield (`YSTEREO`) will be 491, and the vertical offset from the bottom of the screen to the bottom of the left eye subfield (`YOFFSET_LEFT`) will be 532 (this might not be true on other machines that use Silicon Graphics GL, such as the IBM RS/6000; in cases where the `YBLANK` is not known, the program may need to allow the user to adjust the vertical alignment of the left and right eye subfields).

Save the original cursor y screen coordinate, and set the cursor so that it will only wander about the range of one eye's subfield:

```
long mouse_loc;
```

```
mouse_loc = getvaluator(CURSORY);
setvaluator(CURSORY, YSTEREO/2, 0, YSTEREO);
```

Save the original matrix mode, and set the matrix mode for projection:

```
short mode;

mode = getmmode ();
mmode (MPROJECTION);
```

### *Setting Up the 3D to 2D Projections*

For non-stereoscopic perspective projections, one normally uses one of two GL commands, `perspective()` and `window()`. Both of these commands assume that the center of projection is at the orgin, and that the projection plane is parallel to the xy plane, intersecting the negative z-axis. Both `perspective()` and `window()` have arguments called `near` and `far`, which indicate the distance from the center of projection to the near and far clipping planes.

When setting up the perspective projections for stereoscopic left and right eye views, we provide two projection routines, `stereoproj()` and `stereopersp()`:

**stereoproj():**

```
void stereoproj (float xmin, float xmax, float
   ymin, float ymax, float znear, float zfar, float
   zzps, float dist, float eye)
{
  float xmid, ymid, clip_near, clip_far, top,
     bottom, left, right, dx, dy, n_over_d;

  dx = xmax - xmin;
  dy = ymax - ymin:
  xmid = (xmax + xmin) / 2.0;
  ymid = (ymax + ymin) / 2.0;
  clip_near = dist + zzps - znear;
  clip_far = dist + zzps - zfar;

  n_over_d = clip_near / dist;

  top = n_over_d * dy / 2.0;
  bottom = -top;
  right = n_over_d * (dx / 2.0 - eye);
  left = n_over_d * (-dx / 2.0 - eye);

  window(left, right, bottom, top, clip_near,
    clip_far);

  translate (-xmid - eye, -ymid, -zzps - dist);
}
```

This routine sets up the perspective projection for the left eye or right eye subfield of a stereoscopic view. Unlike `stereopersp()`, this routine works for any coordinate range. Using `stereoproj()`, the point with 3D coordinates `(xmin, ymin, zzps)` should end up in the lower left corner of

# ESCAPING FLATLAND: The Benefits of Stereo Viewing

BY BART EISENBERG

While most users never consider it, nearly all three-dimensional applications are actually displayed in two dimensions. A solid model, for example, can be rotated and shaded. But it is still displayed as a 2D projection on a flat screen.

The ability to display a 3D image in 3D is what distinguishes stereo-ready computer systems and applications. Unlike their "flat world" counterparts, they allow the user to sense depth.

True depth perception occurs when each eye sees the world from a slightly different perspective. Our minds fuse these two images into a single stereoscopic image. A stereo-ready system replicates this phenomenon by delivering two slightly different images, one to each eye. In the case of computers, the software itself generates the left and right perspectives. In video, two cameras positioned slightly apart provide the source.

The resulting stereo pairs are displayed sequentially on a monitor. StereoView™ or CrystalEyes™ electronic eyewear, liquid crystal viewing devices, synchronized with the monitor, channel the appropriate image to the appropriate eye. For example, when the left image is on the video screen the left lens is open while the right lens is closed.

### *The benefits of stereo viewing*

Stereo viewing systems are now being used in a wide variety of applications, from architecture and mechanical CAD to business and sales presentations. Stereoscopic applications have been written for battlefield management and flight simulation, mapping and earth resource planning, automobile design and fluid dynamics. Currently, molecular modeling is a major application.

The benefits can be dramatic. One study found that the use of a 3D display eliminated 75 percent of the errors made by engineers designing sheet metal parts: the systems helped them better visualize the process.

the screen, and that with coordinates (xmax, ymax, zzps) should end up in the upper right corner of the screen.

xmin, xmax, ymin, ymax = the coordinates in the plane of zero parallax setting that are displayed on the screen
znear, zfar = the z-coordinate values of the clipping planes; zfar should be less than znear since the viewing direction is along the negative z-axis
zzps = the z-coordinate of the plane of zero parallax setting; zzps should lie between znear and zfar
dist = the distance (positive number) from the center of projection to the plane of zero parallax
eye = half the eye separation; positive for right eye view, negative for left eye view

**stereopersp():**

```
void stereopersp (int fovy, float aspect, float
  near, float far, float dist, float eye)
{
  float left, right, top, bottom, gltan;

  gltan = tan(fovy / 10.0 / 2.0 * M_PI / 180.0);

  top = gltan * near;
  bottom = -top;

  gltan = tan(fovy * aspect / 10.0 / 2.0 *
    M_PI / 180.0);

  left = (-gltan - eye / dist) * near;
  right = (gltan - eye / dist) * near;

  window (left, right, bottom, top, near, far);

  translate (-eye, 0.0, 0.0);
}
```

This routine sets up the perspective projection for the left eye *or* right eye subfield of a stereoscopic view, in much the same way that the perspective() command sets up the perspective projection for a non-stereoscopic view. stereopersp(), like perspective(), requires that the center of projection be the origin, with the direction of view along the negative z-axis. So, translate before doing the projection, by putting translate() after the stereopersp() call.

fovy = vertical field of view angle, specified in tenths of degrees
aspect = ratio (positive number) between horizontal field of view angle and vertical field of view angle
near = distance (positive number) from center of projection (origin) to the near clipping plane
far = distance (positive number) from center of projection to the far clipping plane
dist = the distance (positive number) from the center of projection to the plane of zero parallax
eye = half the eye separation; positive for right eye view, negative for left eye view

## *Converting Projections To Pixel Values*

The above projections do more than change 3D coordinates to 2D; they project the coordinates to a (–1.0 to 1.0, –1.0 to 1.0) range corresponding to the boundaries of the display window. However, we do not want the projections to fill the display window. We want the left eye projection to be drawn to the upper portion of the screen, and the right eye projection to be drawn to the lower portion of the screen. To accomplish this, we use the viewport() command. For the left eye, use

```
viewport(0, getgdesc (GD_XPMAX) ,
  YOFFSET_LEFT, YOFFSET_LEFT +YSTEREO) ;
```

and for the right eye view, use

```
viewport(0, getgdesc(GD_XPMAX), 0, YSTEREO);
```

These commands should appear before the stereoproj() or stereopersp() commands, making them the last transformation on the stack to be applied to the scene.

## *Before Exiting*

Upon getting a Quit request from the user, changes to the environment must be undone. Most importantly, the hardware must be told to get out of stereo mode, and the cursor range must be restored to full screen. You will also want to restore the matrix mode:

```
/* monitor, mouse_loc, and mode were saved dur-
   ing initialization */
setmonitor(monitor);
setvaluator(CURSORY, mouse_loc, 0, getgdesc
   (GD_YPMAX);
mmode (mode);
```

## *Sample Source Code*

The following source code example demonstrates how to write a simple stereo application in the IRIS Graphics Library. This application puts a crude stereo image of a paper airplane on the screen, rotating about its center. To quit, the user presses the escape key, or selects quit from the application window menu.

```
/*
   plane.c
   by Robert Akka
   StereoGraphics Corporation
   To compile: cc plane.c -o plane -lgl
*/

#include <stdio.h>
#include <gl.h>
#include <device.h>
#include <get.h>
#include <gl/addrs.h>
#include <gl/cg2vml.h>
```

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  - ☐ Computing
  - ☐ Petroleum
  - ☐ Textiles
  - ☐ Other
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  - ☐ Dept. of Energy
  - ☐ Dept. of Trans.
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  - ☐ NASA
  - ☐ Other
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  - ☐ Architecture
  - ☐ Engineering
- ☐ **Research**
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- ☐ Finite Element Analysis
- ☐ Fluid Dynamics
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- ☐ Mechanical CAD/CAM
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- ☐ Molecular Modeling
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- ☐ Robotics
- ☐ Scientific Visualization
- ☐ Other (Specify)_____

**My IRIS workstation is a:**

- ☐ Power Series
- ☐ 4D/G
- ☐ Personal IRIS
- ☐ 4D/GT
- ☐ 1000/2000/3000
- ☐ _____

**The number of IRIS workstations at my site is:**

- ☐ 1–5
- ☐ 11–20
- ☐ More than 50
- ☐ 6–10
- ☐ 21–50
- ☐ None

**Software Utilized:**

- ☐ Public Domain Software *(please specify)*
- ☐ Custom Software
- ☐ Third-Party Software

_____

**My job function is:**

- ☐ Corporate Mgt.
- ☐ Engineering Mgt.
- ☐ Research Staff
- ☐ Marketing
- ☐ Engineering Staff
- ☐ Other_____
- ☐ Consulting
- ☐ Creative Staff

_____

**My organization's total sales volume or budget:**

- ☐ Less than $100,000
- ☐ $101,000–$1 Billion
- ☐ More than $1 Billion

**Number of employees at my company:-**

- ☐ Under 250
- ☐ 251–5000
- ☐ 5000 or more

**I purchase or influence the purchase of the following graphics and imaging products:**

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- ☐ Plotters
- ☐ Storage or memory devices
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**Do you use or own an SGI workstation?** ☐ **Yes** ☐ **No**

If so, what is the serial number?_____

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- ☐ Mastering IRIX
- ☐ System Administration
- ☐ Network Fundamentals
- ☐ Self-paced Personal IRIS Maintenance
- ☐ System Maintenance
- ☐ Multi-processor Maintenance

**Comments or Questions:**

_____

_____

_____

```
#define YSTEREO 491          /* subfield height in
  pixels */
#define YOFFSET_LEFT 532 /* YSTEREO + YBLANK */
/* #define PRE_IRIX33     uncomment this #define
  if not running on IRIX 3.3 or later */
#define SPEED 10 /* this should be an int that
  divides evenly into 3600 */
#ifndef PRE_IRIX33
#define XMAXSCREEN getgdesc (GD_XPMAX)
#define YMAXSCREEN getgdesc (GD_YPMAX)
#endif

main()
{
  int position = 0, dev_id;
  short value, mode;
  long monitor, mouse_loc;

        /* open full screen window */
  prefposition(0, XMAXSCREEN, 0,
    YMAXSCREEN);
  winopen("");

  monitor = getmonitor();     /* save monitor
    mode */
  if (is_stereo())          /* if hardware is
      stereo-ready . . . */
    setmonitor(STR_RECT); /* . . . change
      hardware to stereo mode */
  else {
    printf("Error: Hardware is not stereo-
      ready.\n");
    exit(0);
}

mouse_loc = getvaluator(CURSORY);
  /* save mouse y location */
mode = getmode();        /* save matrix mode */
mmode(MPROJECTION);          /* set projection
  matrix mode */
doublebuffer();
RGBmode();
gconfig();
gdevice(ESCKEY);
qdevice(WINQUIT);

   /* clear both front and rear buffers */
  viewport(0, XMAXSCREEN, 0, YMAXSCREEN);
  frontbuffer(1);
  cpack(0x00111111);     /* grey background */
  clear();
  frontbuffer(0);
        /* limit mouse to one subfield */
  setvaluator(CURSORY, YSTEREO / 2, 0,
    YSTEREO);

   /* redraw rotating image until quit */
```

*Boston's Central Artery/Third Harbor Tunnel Project.* An example of a WALKTHRU™ image to be viewed in stereo for design reviews. The project scope includes replacing three miles of elevated freeway that runs through downtown Boston with an underground tunnel. The project cost is estimated at $4.9 billion and it will take 10 years to complete.

A major portion of the city of Boston was modeled with a CAD system and animated with WALKTHRU. This particular slide was taken from a WALKTHRU video output used to simulate driving through the tunnel to test the design.

Stereo viewing makes it easy to interpret and manipulate complex models, from wireframe to fully rendered solid models. Consider a rotating wireframe of the space shuttle. Viewed on a conventional system, the observer can easily confuse the relative positions of the fuselage. When viewed in stereo, all ambiguity is removed and spatial relations are obvious.

Stereo viewing substantially reduces modeling costs. Prototype models are effectively created completely in stereo 3D, postponing the need for a physical model until the design is complete. An engineer can immediately grasp the intricacies of a jet engine or refinery pipe system.

In the related fields of architectural and product design, a stereo "walkthrough" demonstration can create a realistic sense of the complicated project that a 2D or even conventional 3D depth-cued presentation might not accomplish.

In computational chemistry, stereo viewing helps researchers visualize and design complex molecules. Stereo viewing allows certain required operations to be performed much more quickly. A molecular modeling docking procedure that took four to five days to complete takes just four to five *hours* with stereo viewing.

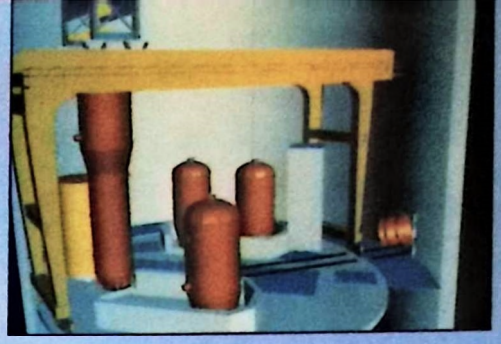
## *Easy to implement*

Converting a 3D application to a true stereo application is surprisingly easy. The developer need only create an alternate image from an alternate view perspective and set it up in the proper geometry. The resulting two images constitute the stereo pair.

Consider, for example, Bechtel Corporation's WALKTHRU™ software. Engineers use

```
  while (1) {

    if (qtest()) {
      dev_id = qread(&value);
      if (dev_id == ESCKEY || dev_id == WINQUIT)
        break; /* leave while loop if quit or
          escape selected */
    }
    redraw (position--);
    if (position < 0)
      position = 3600 / SPEED;
  }
   /* restore to original state and quit */
  setvaluator(CURSORY, mouse_loc. 0,
    YMAXSCREEN);
  setmonitor(monitor); /* get out of stereo
    mode */
  mmode (mode);  /* return to original matrix
    mode */
  exit (0);
} /* end of main */

int is_stereo() {
/* This routine returns 1 if hardware is
   stereo-ready, 0 if not */
  long rw1, rw2;
    /* for pre-IRIX 3.3 systems, we test to see
       if they DER1_STEREO bit is read/write or
       read-only; if read-only then stereo-
       ready */
#ifdef PRE-IRIX33
  rw1 = getvideo(DE_R1);
  rw2 = rw1 ^ DER1_STEREO;
  setvideo (DE_R1, rw2);
  rw2 = getvideo(DE_R1);
  if (!(rw1 == rw2))
    return(1);
  rw1 = rw2 ^=DER1_STEREO;
  setvideo(DE_R1, rw2);
  rw2 = getvideo(DE_R1);
  return(!(rw1 == rw2));
#else
  return(getgdesc(GD_STEREO));
#endif

} /* end of is_stereo */

redraw(position)
int position;
/* This routine puts a stereo image of a paper
   airplane onto the screen */
{
            /* draw left subfield */
  viewport(0, XMAXSCREEN, YOFFSET_LEFT,
    YOFFSET_LEFT + YSTEREO);
  cpack(0x00111111);      /* grey background */
  clear();

    /* z-coordinate of plane of zero parallax
         is 0.0
       In that plane, the coord range drawn to the
         screen will be (-6.0 to 6.0, -4.8 to 4.8).
       z-coordinate clipping planes are -6.0
         and 6.0.
       The eyes are set at world coord distance
         14.5 from the plane of zero parallax,
         and the eye separation is 0.62 in world
         coords. */
  stereoproj(-6.0, 6.0, -4.8, 4.8, 6.0, -6.0,
    0.0, 14.5, -0.31);

  rotate(position * SPEED, 'y');
  rotate(-100, 'x');
  draw_airplane();

            /* draw right subfield */
  viewport (0, XMAXSCREEN, 0, YSTEREO);
  cpack (0x0x00111111); /* grey background */
  clear();

    /* Same as above stereoproj() call, except
       that eye arg is positive */
  stereoproj(6.0, 6.0, -4.8, 4.8, 6.0, -6.0,
    0.0, 14.5, 0.31);

  rotate(position * SPEED, 'y');
  rotate(-100, 'x');
  draw_airplane();

  swapbuffers(); /* update screen */
 } /* end of redraw */

draw airplane()
/* This routine draws a crude ''paper
   airplane.'' */
{
 static float airplane [9] [3]] = {
   { 0.0, 0.5, -4.5 },
   { 3.0, 0.5, -4.5 },
   { 3.0, 0.5, -3.5 },
   { 0.0, 0.5, 0.0 },
   { 0.0. 0.5, 3.25 },
   { 0.0, -0.5, 5.5 },
   {-3.0, 0.5, -3.5 },
   {-3.0, 0.5, -4.5 },
   { 0.0, -0.5, -4.5 }
 };

 cpack(0x00b030ff); /* set color to violet */

 bgnclosedline();
   v3f(airplane[6]);
   v3f(airplane[7]);
   v3f(airplane[1]);
   v3f(airplane[2]);
   v3f(airplane[4]);
 endclosedline();
```

```
  bgnclosedline();
    v3f(airplane[0]);
    v3f(airplane[4]);
    v3f(airplane[5]);
    v3f(airplane[8]);
  endclosedline();

  bgnline();
    v3f(airplane[6]);
    v3f(airplane[3]);
    v3f(airplane[2]);
  endline();
} /* end of draw_airplane */

stereoproj(xmin, xmax, ymin, ymax, znear, zfar,
   zzps, dist, eye)
float xmin, xmax, ymin, ymax, znear, zfar, xxps,
   dist, eye;
/* This routine performs the perspective
     projection for one eye's subfield.
   The projection is in the direction of the
     negative z axis.
   xmin, xmax, ymin, ymax = the coordinate range,
     in the plane of zero parallax setting, that
     will be displayed on the screen. The ratio
     between (xmax-xmin) and (ymax-ymin) should
     equal the aspect ratio of the display.
   znear, zfar = the z-coordinate values of the
     clipping planes.
   zzps = the z-coordinate of the plane of zero
     parallax setting.
   dist = the distance from the center of projec-
     tion to the plane of zero parallax.
   eye = half the eye separation; positive for the
     right eye subfield, negative for the left eye
     subfield. */
{
  float xmid, ymid, clip_near, clip_far, top,
    bottom, left, right, dx, dy, n_over_d;

  dx = xmax - xmin;
  dy = ymax - ymin;
  xmid = (xmax + xmin) / 2.0;
  ymid = (ymax + ymin) / 2.0;

  clip_near = dist = zzps - znear;
  clip_far = dist + zzps - zfar;

  n_over_d = clip_near / dist;

  top = n_over_d * dy /2.0;
  bottom = -top;
  right = n_over_d * (dx / 2.0 - eye);
  left = n_over_d * (-dx / 2.0 - eye);

  window (left, right, bottom, top, clip_near,
    clip_far);

  translate(-xmid - eye, -ymid, -zzps - dist);
} /* end of stereoproj */
```



An example of a WALKTHRU image to be viewed in stereo for maintenance planning and interface checking. Here WALKTHRU is used to plan the removal and replacement of a 350 ton steam generator at a nuclear power plant. The generator had to be moved through a small opening with less than an inch of clearance. WALKTHRU allowed planners to animate the process with engineering accuracy.

WALKTHRU detected an interference and allowed planners to correct the problem before the removal was underway.

the animation visualization system to test and perfect designs for power plants, petrochemical facilities, and other complex projects. The software is used internally and marketed externally by Bechtel's software division.

WALKTHRU allows users to move around freely within their computer models, changing lighting, moving objects, and checking for interferences. By adding stereo 3D capability, Bechtel was able to increase the level of visual realism the users achieve.

While it took developer Vernon Francisco about a year to create WALKTHRU, he was able to convert it into true stereo in a single day.

"The project appeared complex, but it turned out to be quite simple," said Francisco. "That appears to be the general experience of other developers I've talked with. The process is so straightforward that I was even able to use sample source code that I found in an *IRIS Universe* article."

Software developers wishing to adapt 3D applications for Silicon Graphics hardware, including the new IrisVision™ system, can take advantage of a program offered by StereoGraphics Corporation. (San Rafael, CA.). The company offers developers technical and marketing support, as well as a complementary pair of electronic eyewear. The StereoGraphics development program also makes its equipment available to Silicon Graphics application venders exhibiting at trade shows.

---

*Bart Eisenberg is a freelance writer in San Rafael, California.*

*For more information about the benefits of stereo viewing contact the Developers Program Manager, StereoGraphics, (415) 459-4500. FAX: (415) 459-3020.*

Collaboration

# SCIENCE, ART, & CHAOS

BY DR. GOTTFRIED JOSEF MAYER-KRESS, Ph.D.

Traditional tools, such as mathematical equations and formulas, are no longer sufficient in describing the science of complex and chaotic systems. Graphical and even multi-media tools have become increasingly important. In the early 1980s I used comparatively primitive tools (three-pen plotters) to create graphic representations of nonlinear, chaotic structures. Long before publication of *The Beauty of Fractals* I saw the potential in this material for artists. But I also knew that I — a scientist without artistic talent or training — was not the person who would uncover these other, non-scientific layers of chaotic structures.

I had a friend at that time who was an art student. One day I invited her over to the computer lab and showed her the fractal images. However, she was not especially impressed, though she did sit down at the computer and experiment with mixing colors.

Not long afterwards, I gave a talk in New Mexico at the Santa Fe Center for Contemporary Art where I showed slides of fractal images. I had a similar response: Decorative but definitely not art. What surprised me was that the artists got excited over old view-graphs I had with me of mechanical chaos experiments and chaotic brain wave data. I realized that to create something other than visual fast food requires an artistic eye.

In creating the image of the Chirikov standard map (figure 1) my intention was to demonstrate two different properties of chaotic systems. Starting with a few hundred horizontal lines of identical color we observe how these lines are deformed and finally completely mixed up, but only in certain "chaotic" bands (in Jenifer Bacon's landscapes, such as "Canyons and Mesas," figure 2, this corresponds to very rugged areas), whereas there are always regions for which stable order persists and forms islands or chains of islands. This is a typical metaphor for chaotic systems. It also has some real applications — and was originally conceived in the context of the "beam-beam interactions" of interacting storage rings in particle physics. There the particles move approximately at the speed of light and therefore "feel" each other's presence only through an instantaneous kick, which then can be described by a discrete map such as the "standard map" described above. The standard map has also been used to describe phenomena of multi-photon absorption and quantum chaos, a very recent and exciting field of active research in which the photo-electric effect, for which Einstein received the Nobel prize, appears in a completely new light.

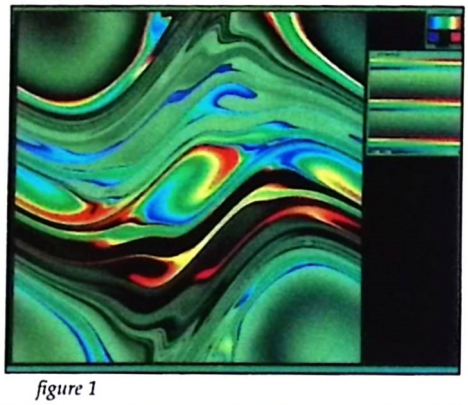


*figure 1*

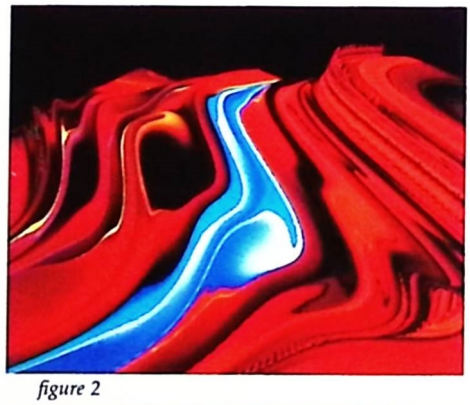
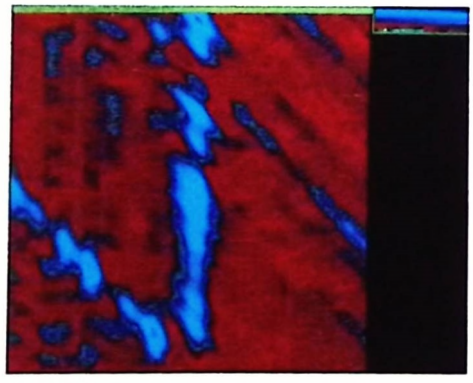


*figure 2*



An interesting recent development in the visualization of complex processes is represented by the recurrence plots of figure 3. Here an observed process (in this case a measured heart rate, evolving in time — no, the heart is not a regular clock, it develops complex, chaotic patterns, at least as long as it's healthy) is represented by its recurrence patterns. A pattern is defined by a vector consisting of a set of points in the

*(continued on page 46)*

*Calligraphy by Inja Ink*

*In a fascinating convergence of art and science, an artist using an IRIS workstation has created landscape "paintings" based on visualizations developed by a scientist studying chaos theory*

# ART, SCIENCE, & CHAOS

BY JENIFER BACON

Last year while at Princeton University I began a collaboration with Gottfried Josef Mayer-Kress working with computer images that he had generated for scientific research in chaos. It was an opportunity for me as a graphic artist to not only work directly with a scientist, but also to learn to use the IRIS workstation and Princeton Visualization Tools. When I began the project my sole purpose was to work with the images in order to clarify them for scientific visualization. The images would still be computer models of chaotic systems to be used for science. I had seen chaos and fractal images in the past. I regarded them as intriguing scientific images but not art.

In one afternoon I learned to use the Princeton Visualization Tools, the IRIS workstation, and began work. The standard "makemap" color map was used for the initial images I received from Mayer-Kress (figure 1). At first I felt there were too many colors all mixed together, which was distracting. However, there was something intriguing about the structure of the images. They seemed to flow and move like liquid or vapor and I began to see them as raw material. It was as if I were a painter and had gone outdoors with canvas and oil colors to paint a landscape. The chaos images on the computer put me in mind of the land and sky — I could paint and interpret them as I wished. The flexibility and power of the IRIS workstation enhanced the work, allowing the process to become spontaneous and playful.

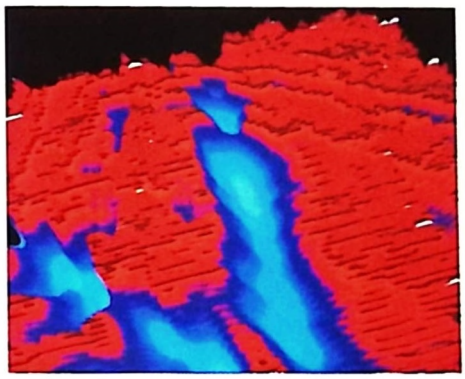


*figure 3*

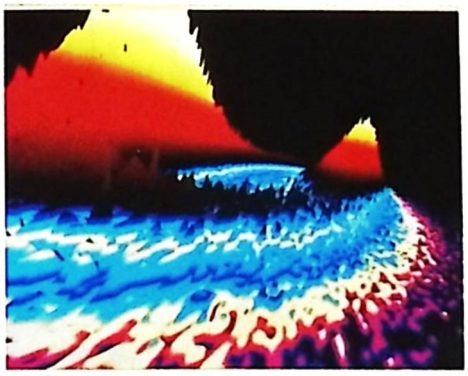
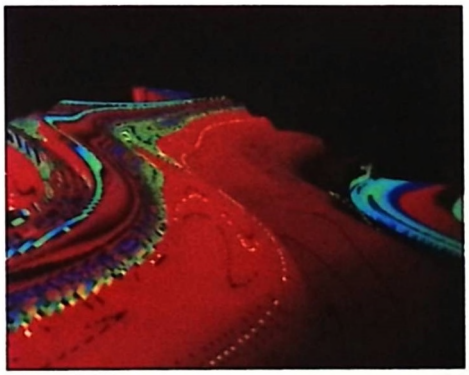


*figure 4*



My first step was to search the image and determine if there were any inherent patterns. In the interest of simplification I eliminated the mix and jumble of colors. I wasn't interested in merely creating pretty pictures; I was looking for a movement or a visual tension in the image that sparked my personal vision. Still, I questioned the value of searching for personal visions in images that are essentially models of particle accelerators, chemical reactions, and heart rates. Painting was far more immediate and allowed absolute freedom along with the challenge of blank canvas. Was there then any value to using these images of chaos to create a personal vision?

The image titled *Canyons and Mesas* (figure 2), originated from the nonlinear mathematical "standard map" of a torus, was transformed into a brilliant landscape full of waves, motion and color. This torus slice, which had formed a strange attractor in the science model, had become a strange surreal landscape in its art version.

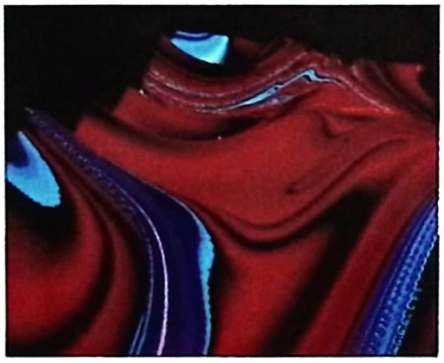
In the image *Blue Canyons* (figure 3) the color map is a recurrance plot of the heart rate of a pig, but the image was manipulated to create a rugged red landscape creased with deep, mysterious canyons.

*Islands* (figure 4) began as a model of a chemical reaction and was transformed into ethereal islands floating down a liquid pathway of pink and blue.

In the creating of these abstract landscapes I had discovered new visual tools which made it possible for me to create unique images that could not have been

*(continued on page 46)*

## SCIENCE *(continued from page 44)*



time series separated by a fixed time interval. The time of the process evolves along the horizontal axis, on the vertical axis we represent the time interval between the pattern at a certain time given by the x-coordinate and a new pattern occurring later. Thus both axes represent times at which patterns are observed. The color indicates how similar these patterns are. If there is some deterministic structure in the evolution of the patterns this then becomes immediately visible in the recurrence plot.

For example, according to a hypothesis expressed by A. Goldberger of the Harvard Medical School, as a heart comes close to a pathological state — such as a heart attack — the complexity, or "chaos," of the heart rhythms should decrease which may then be observed in the more regular structure of the recurrence plot. (For an article on this topic see *Discover* magazine, May 1990.)

In the third example (figure 4) computer graphics were used to describe the stability of a model of an oscillating chemical reaction measured against external, randomly variable agitations. Especially in large chemical reactors it is extremely important to understand how sensitive the system is to small irregularities in the control parameters in order to prevent dangerous run-away reactions or explosions.

Starting from a stable condition for the reaction, we can apply a Chapman-Kolmogorov method to compute the probabilities for the behavior of the system at a given time, averaged over the ensemble of external agitations. The peaks in the figure correspond to states of the chemical system for which there exist constant reaction rates. Adding small external agitations leads to the formation of the "atoll," a situation in which the reaction rate changes in an oscillatory pattern, still with a high probability (z-coordinate) to be found near the original steady fixed points.

Thus we visually observe the evolution of landscapes which describe the statistical properties of the reactions and the conditions under which instabilities might occur. This class of nonlinear equations is very general. Such equations can also model the stability of ecologies and also have been used to describe crisis in the strategic arms race.

## ART *(continued from page 45)*

achieved in any other way.

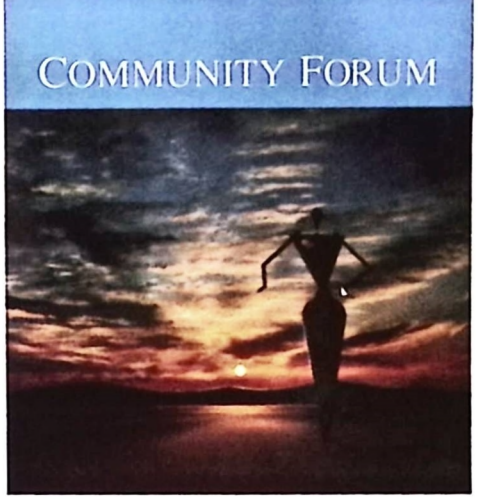
The results of this art/science collaboration were entirely unexpected and went far beyond what Dr. Mayer-Kress and I had anticipated. My intent was to use Mayer-Kress's images as a point of departure, a basis on which to create something more than brightly colored computer graphics — as a vehicle for self expression.

While computer visualization technology is encouraging the convergence of science and art, we are also reminded that age old, fundamental differences exist between the two disciplines. Visualization in the sciences is typically used as a means of representing data so that it may be better understood or communicated to others. Visualization as applied in the arts is not so much a representation of data as it is a representation of the artist's imagination and feelings.

---

*Gottfried Josef Mayer-Kress holds a Ph.D. in Theoretical Physics from the University of Stuttgart, West Germany. He is a visiting Assistant Professor in the Department of Mathematics at the University of California, Santa Cruz.*

*Jenifer Bacon is Art Director at Tygenhof & Partners, a Southern California advertising agency.*



Courtesy of LINKS Corporation, Japan.

### Visualization in Engineering and Science

The Visualization in Engineering and Science Conference will be held August 22-23, 1991 in Linkoping, Sweden. The conference goal is to demonstrate, motivate, and promote graphics visualization in a diversity of fields and applications. A further objective is to provide a meeting place for professionals and researchers in industry, government agencies, and the academic world. A number of prominent international scholars and researchers will be guest speakers.

For more information, contact: Ingrid Nyman, Linkoping University, S-581 83 Linkoping, Sweden, 46 (13)28 1148 or fax 46 (13)12 2299.

### Computer Animation '91

Computer Animation '91 is the third conference on computer animation organized by the University of Geneva, the Swiss Federal Institute of Technology and CGS. The May 22-25, 1991 conference in Geneva, Switzerland features paper presentations and a film festival.

Original research results and applications experience will be presented in the following areas: paint systems, motion control, keyframe animation, path planning, mechanics-based animation languages and systems, description of filmmaking, special animation hardware, animation for scientific visualization, animation in engineering, motion blur and temporal anti-aliasing, AI based animation, robotics and animation, video animation, special effects sound synchronization, speech synchronization, and recording techniques.

For more information, contact: Daniel Thalmann, Computer Graphics Laboratory, Swiss Federal Institute of Technology, CH-1015 Lausanne, Switzerland, (41) 21-693-5214, fax (41) 21-693-3909, or email: thalmann@eldi.epfl.ch.

### Hot Chips III Symposium

The Hot Chips Symposium is back. Sponsored by the IEEE Computer Society Technical Committee on Microprocessors and Microcomputers, the symposium will be held August 26-27, 1991 at Stanford University. The General Chairman is Martin Freeman of Philips Research with Program Co-chairs Forest Baskett of Silicon Graphics and John Hennesy of Stanford University.

Hot Chips III includes presentations on high-performance chip and chip-set products, and related topics. This conference is specifically focused on new and exciting products. The emphasis is on real products, not academic designs. Participants will not be required to prepare written papers. The proceedings will consist of copies of the slides to be presented.

For more information, contact: Martin Freeman, (408) 991-3591 or mfreeman@sierra.stanford.edu.

### Seybold Digital World

Corporate leaders and experts from the communications, publishing, computer and entertainment industries are set to speak at Seybold Digital World, June 4-6, 1991 at the Beverly Hilton Hotel in Beverly Hills, California. Speakers scheduled to appear include: Steven Jobs, NeXT; Howard Mirowitz, Mitsubishi; Seth Homayoon, FiberWorld/Northern Telecom; Diana Gagnon, ACTV; Michael Backes, consultant, Trip Hawkins, Electronic Arts; Olaf Olafsson, Sony Electronic Publishing; and Robert Winter, UCLA Music Department.

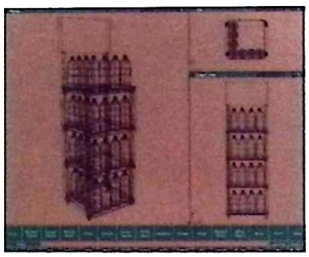
Running concurrently is the Digital World DemoCenter where companies demonstrate the latest in digital technology in a hands-on atmosphere. For more information, contact: Seybold Seminars, 6922 Wildlife Road, P.O. Box 578, Malibu, California 90265, (213) 457-5850 or fax (213) 457-4704.

### 3D Threesome Produce New Silicon Graphics Manufacturing Facility

Silicon Graphics has constructed a major new manufacturing facility in Neuchatel, Switzerland to respond to the rocketing demand in Europe for Personal IRIS workstations. The design of this high-tech facility was carried out by Studio of San Francisco and the local adaption was done by Neuchatel architect, Robert Vincent. CADIAM TV's implementation group was actively involved in the creation of 3D visualizations for the new center. Project co-ordination was undertaken by Silicon Graphics' own facility management team. Sonata software was used by all three teams in the design and construction phases.

Edwin Douglass, Silicon Graphics' Constuction and Facilities Manager, felt that Sonata's unique building modeling approach would ensure a smooth construction phase and timely project completion. John Watts, CADIAM TV's Director of Market Development, commented, "We were so impressed with the hardware that we became worldwide Value Added Resellers and joined Silicon Graphics' Geometry Partners Program."

# The new Alias Designer. It's being called an unfair competitive advantage.



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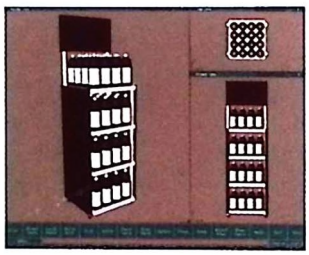

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